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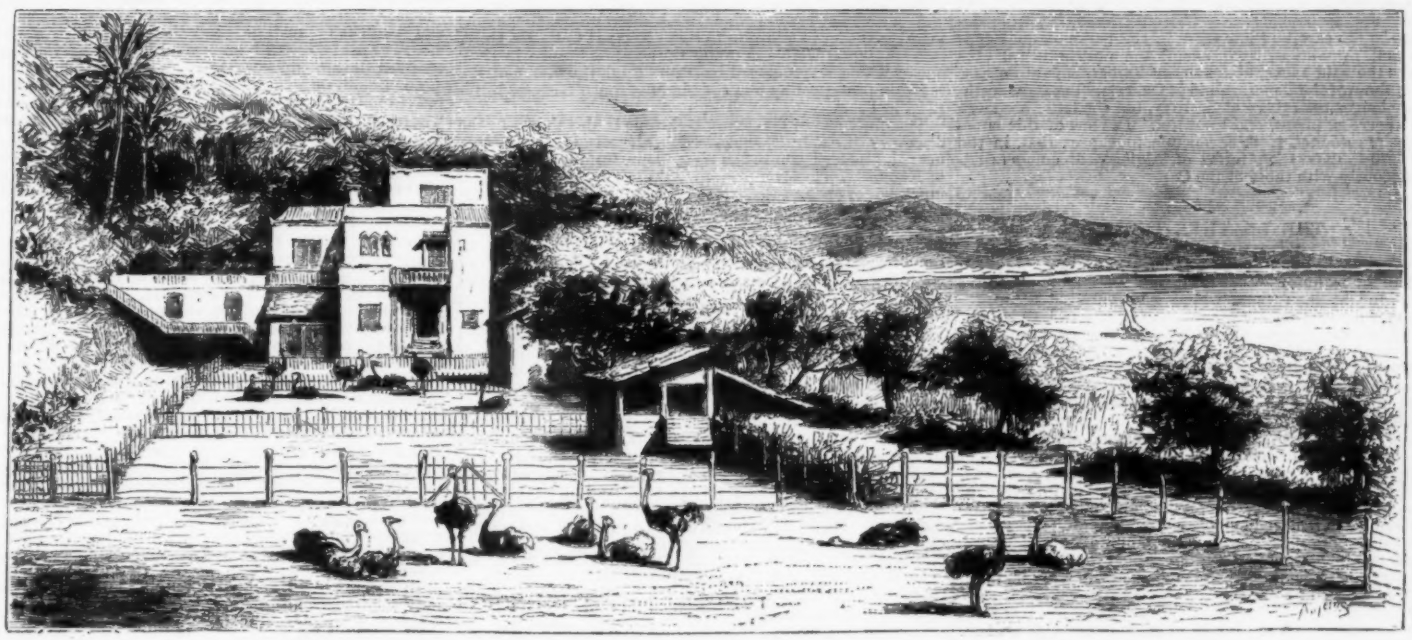
GENERAL VIEW OF AN OSTRICH PARK AT KOUBA, ALGIERS.



PARK FOR YOUNG OSTRICHES.

PARK FOR THE SITTING FEMALES.

THE OSTRICH PARKS OF ALGIERS.

THE OSTRICH PARKS OF ALGIERS.

For some time past considerable attention has been paid to the rearing of ostriches in the French colony of Algeria, in imitation of the example of the Cape, where this industry has been in successful operation for eighteen years. One of the interesting facts connected with ostrich farming at the Cape is the rapid increase in the number of the birds; in 1865 there were only 85 ostriches there, in 1875 there were 32,000, and now the number reaches 160,000. An ostrich stands the owner in about 350 francs, and is sold at from 1,000 to 3,500 francs. These figures are certainly worthy of the reflection of those living in such parts of Africa as are favorable to the prosecution of this industry. Ostrich raising in Algeria has been proved practicable mainly through the exertions and perseverance of Madame Carrière, who has established at Kouba, near Algiers, a series of parks for rearing young ostriches, for the mated birds, and for the sitting females. Although in the torrid zone the eggs have no need to be incubated, it is otherwise outside the tropics, especially at night time. We give herewith illustrations, made from very exact drawings by M. Louis Say, of these different parks, which, in the near future, will be one of the curiosities of the environs of the capital of Algeria.

In ostrich raising, the expense of feeding is in inverse ratio to the size of the parks in which the birds are kept; so much the less the larger the park. When the birds can find feed for themselves in the inclosure, as they do in the immense ones at the Cape, the expense is reduced to almost nothing, but it increases in proportion as the park is more limited in dimensions. Madame Carrière's parks are small, since land is dear at Algiers; but fortunately this is otherwise in other parts of the colony. The reproduction of the ostrich may be either natural or artificial. When natural, it takes longer and produces less, for it is always attended with more or less loss, and it moreover spoils the feathers of the sitting bird. Artificial reproduction, which has made the fortune of the ostrich farms of the Cape, has fewer inconveniences and is much more productive, but is applicable only in large establishments where there is an extensive yield of eggs. It was only recently that this method could be adopted at Algiers. There are several models of artificial incubators in use, all based on the same principle—that of maintaining a uniform temperature of 38° C. by means of currents of hot water passing around the drawers containing the eggs.

The feathers of the ostrich are of course the final aim and end for which all the labor is performed. The price of these depends upon their beauty. By selection, the English have obtained for their feathers what they have obtained at London for the bovine race. Their ostriches, far from degenerating in captivity like those in the parks of the Egyptians and Tripolitans, have become the most beautiful race next to the wild ones of the States of Barbary, of the Sahara, and of those of the Touaregs and of Ouargla. The Cape feathers are longer than those of Barbary, but the latter are more silky, floccose, pliant, and beautiful. In view of this superiority of product, it is reasonable to expect that, in the near future, the ostrich farms of Algiers will compete advantageously with those of the Cape.

THE LEATHER TURTLE.

By JOHN FORD.

In all the realm of nature few avenues are more attractive to the student than those which lead into the ocean, for though trodden from time immemorial, a peculiar glamour still haunts the almost impenetrable veil beyond which they end. Such a mysterious charm might of itself awaken an interest in the minds of men. But an incentive far more potent is found in the hope that behind this shadowy veil thousands of unknown forms of life are hidden, awaiting only the coming of some modern Aladdin, at whose touch the doors of their habitations shall fly open and their strange and weird beauty be revealed.

That myriads of living creatures do people these wondrous depths, is shown by the appearance, at intervals, of the more venturesome ones on our shores, inciting the careful observer to renewed efforts in the study of their forms, their habits, and their previous surroundings.

It is true that many problems regarding the latter must of necessity remain unsolved, yet much may be studied and much be learned by patient and persistent endeavor.

With this purpose in view I have collected a few facts respecting the recent advent of specimens of *Sphargis coriacea*, a species as little known to the general reader, perhaps, as any other of like dimensions found in the Atlantic. The animal has indeed been referred to by a number of writers, but in all probability their stock of information has, in most cases, been derived from hearsay rather than from direct examination of specimens. In an English work on general zoology, published by Dr. George Shaw in 1802, we are informed that the coriaceous tortoise is a native of the Mediterranean, albeit specimens had been taken now and then on the coast of England; and of one captured in 1729 near the river Loire, in France, the author remarks: "It is said to have uttered a hideous noise when taken; its mouth at the same time foaming with rage and exhaling a noisome vapor." He also adds that, according to Lacepede, "the coriaceous tortoise is one of those with which the Greeks were well acquainted, and he supposes it to have been the species particularly used in the construction of the ancient lyre or harp, which was at first composed by attaching strings to the shell of some marine tortoise."

The first specimen seen in this latitude, of which I can find any record, was captured in Chesapeake Bay in the year 1840. This was measured by Dr. E. Hallowell, an eminent herpetologist, but his figures differ so slightly from others made more recently, it is unnecessary to repeat them. As, however, the description given in the second volume of "North American Herpetology," a work published in 1842, by Dr. John Edwards Holbrook, was the result of an examination of this specimen, it is reproduced here in a somewhat condensed form, as follows:

"*Characters.*—Head large, jaws strong, superior having three deep triangular notches, inferior hooked; body covered with a coriaceous skin, tuberculated in the young, smooth in adult animals; extremities without nails.

"*Description.*—The carapace is sub-cordiform, largest before and deeply concave on the neck; it is narrow and pointed behind and above, and is marked with seven longitudinal carinæ, one of which runs along the entire vertebral line. On either side of this are three others, the external ones following the margin of the carapace from its anterior to its posterior extremity, where they meet in a point above the tail. The nostrils are anterior and near together. The neck is short, very thick, and covered with a coriaceous skin. The anterior extremities are twice the length of the posterior ones. The tail is short and extends but little beyond the carapace. The whole superior surface of the animal is of a dark brown color with the exception of the carinæ, which are tinged in different places with obscure dirty white."

A very fair portrait of *Sphargis coriacea* accompanies this description.

So far as I can learn no later evidence has been given of the presence of Sphargis on our shores prior to the summer of 1878, when four specimens were stranded upon the coast of New Jersey. Of these two were doubtless first discovered near Atlantic City by the writer and a friend, Mr. Chas. Morris, one of them, in fact, being observed for some time before it was borne by the waves to our feet. They were both dead, though otherwise in good condition.

The two others mentioned were landed at a later period near Beach Haven, Ocean County. In reference to them, Isaac Hall, an old sea captain, remarked, that "he had seen turtles of all kinds, but these were the largest he had met in any quarter of the globe."*

In the early part of the present year (1879) a fine specimen was shot off the coast near Wilmington, North Carolina, by Capt. Chadwick, of that city; and still later another was caught at Gloucester, Virginia, by Mr. W. H. Ash, the wharf agent at the point, who struck it a powerful blow on the head with an oar, stunning it and making it an easy prey.

The former of these, which is said to have measured seven feet in length by three and a half feet in width, appears to have puzzled the good people thereabouts in regard to its true character, some calling it a turtle and others a devil-fish, while the captain held to the opinion that it was Old Nick himself. Unfortunately, however, for their future prospects, it proved to belong to the species under consideration; "more's the pity," perhaps.

The specimen taken at Gloucester Point, though smaller than the last mentioned, was none the less surprising to its captor and others who saw it, many of them being of the same opinion regarding the fate of "Old Nick" as their more southern brother.

With the exception of one taken alive in Delaware Bay, June 1, 1879, the above half dozen specimens comprise, so far as any records appear, the whole number found on our coast since 1840, a fact which seems to corroborate the opinion of Dr. Holbrook, who assumed that they were quite rare in American waters. Nevertheless, Dr. Leidy, Mr. John A. Ryder, and others, who have given the subject much attention, believe them to be more plentiful than has been supposed.†

As a proof at least of their wide distribution, it may be mentioned that in addition to those referred to by Dr. Gray, two specimens were cast up on the coast of France in 1872; one of which was obtained by Prof. Paul Gervais, and the skeleton preserved by him for the Museum d'Histoire Naturelle, at Paris.

The great age of the genus in Europe is also shown by the discovery of *Sphargis pseudostracion*, Gervais, in the Miocene, near Montpellier. *Protostega gigas*, Cope, from the Cretaceous of Kansas, is closely allied to *Sphargis coriacea*, though a much larger species, the length being 12.8 feet, and the width from tip to tip of the anterior flippers, 11.3 feet.

Two other species, *P. neptunia* and *P. tuberosa*, the former from the Cretaceous of New Jersey, and the latter from the same formation in Mississippi, have also been described by Prof. Cope, which seems to prove that the genus Protostega was quite as prevalent in Cretaceous seas as is Sphargis in those of the present.

Unfortunately the specimen captured in Delaware Bay and brought to Philadelphia, lived but a short time afterward; its death having been hastened by an injury received from a boat hook or other weapon during the struggle to capture it.

The chance of seeing such a huge denizen of the ocean was a rare one, however, and very many citizens, including some eminent naturalists, took advantage of it. As a precautionary measure, the animal was kept upon its back; nevertheless, the muscular power displayed by the creature when trying to regain its normal position was something remarkable. Especially was this the case just previous to dying, when, according to its owner's statement, the united efforts of four men were required to keep it in place.

During a quiet interval the subjoined measurements were taken by the writer, kindly assisted by that careful naturalist, Mr. John A. Ryder:

	Ft.	In.
Entire length of animal	6	7
Length of carapace	5	0
Greatest width of same	3	4
From tip to tip of anterior flippers	8	8
Greatest width of anterior flippers	1	0
From point of beak to edge of carapace	1	3
Diameter of neck	1	0
Elevation	1	4
Width of breast	3	0
Length of tail	0	6

As a subsequent measurement suggested no alteration of the figures given, they may therefore be accepted as approximately correct. The weight of the animal, taken soon after its death, was 765 pounds; as much, perhaps, as the half dozen specimens I have alluded to would average.

It follows, therefore, that these were but a little more than half grown, or that 1,200 pounds, the estimated weight of an adult, as given by Dr. Holbrook, is much too large. A further examination of the specimen, which was fortunately secured by Prof. Cope, will, doubtless, decide the matter. In the meantime, a few of the more prominent characters pertaining to the animal may be profitably referred to. For instance, the mode of respiration in Sphargis is peculiarly marked. This is apparently effected by inflating the throat with air until it is much enlarged, and then by closing the nostrils and contracting the throat, suddenly forcing the air back into the lungs. That this pumping process is common to all the Testudinata is known, but that it effects respiration is denied by Drs. Mitchell and Morehouse, who ascribe this function to the axillary and inguinal muscles.

A much wider difference is found in the skeleton. Thus, in Sphargis the vertebral column is entirely independent of the carapace, while in other genera it is co ossified. It differs also in having the carapace disconnected with all the other parts of the skeleton. Another peculiarity consists in the carapace being composed of a vast number of small bony, irregular tesseræ joined by minute sutures. The plastron is also more rudimentary than that of other turtles, being represented by a mere oblong ring of bones. Of course these embrace the more prominent features. It is not improbable, however, that a careful study of the animal will develop other points of equal interest, in which event the cause of science will be profited.—*Amer. Naturalist.*

* An account of this turtle was given by Dr. D. H. Storer in his Report on the Reptiles of Massachusetts, 1839. The specimen there described was figured on an excellent plate by Dr. Jeffreys Wyman; it "was taken asleep on the surface of the water in Massachusetts Bay, in the year 1824." A specimen weighing about 1,000 lb. was captured in Narragansett Bay in the summer of 1878, and was presented to the Museum of the Brown University, Providence, R. I., where it was stuffed by the Curator, Prof. J. W. P. Jenks.—*Editor.*

† Since the above was written I have learned from Mr. John H. Dusenbury, a Philadelphia dealer, that he received a dead specimen of *Sphargis coriacea* from Delaware Bay, in 1872, which weighed 916 pounds, the skeleton of which was afterward placed in the collection belonging to Mr. O'Brien, the showman.

[Continued from SUPPLEMENT, No. 199.]

GEOGRAPHY.

Opening address by CLEMENTS R. MARKHAM, C.B., F.R.S., F.L.S., Sec. R.G.S., F.S.A., President of Section E, British Association.

HITHERTO I have invited your attention to the basis of geography, to the measurement of the surface of land and sea, and of their heights and depths, to the mapping of the world, and to the innumerable uses of maps and charts. But this only forms the skeleton of our science, which is endued with flesh and blood, with life and motion, by those who study the causes and nature of the changes that have taken place and are now taking place upon the earth; by comparative and physical geographers, by those who study and classify natural phenomena, and demonstrate their connection with each other and their places in the great scheme of nature.

Geography and geology are, from one point of view, sister sciences. The former treats of the earth as it now is and of changes which have occurred within historical times. The latter deals with the condition of the earth and the changes on its surface which went on during the cycles of ages before the dawn of history. The two sciences are quite distinct, while they aid each other. No geological survey can be undertaken without the previous completion of geographical maps, and the geologist is enabled to comprehend the condition of the earth in remote ages by studying the phenomena of physical geography. On the other hand, the geographer acquires a correct understanding of the present state of the earth's surface by considering the records of those marvelous changes which can be gathered from history and from the narratives of travelers and observers in all ages. Without their services, geography would lose half its interest.

Comparative geography (the study of the changes which have taken place on the earth's surface within historical times) is, therefore, a most important branch of our science; and it enlists the historian and the topographer in our service. It is a branch of geography which has not hitherto received the amount of attention it deserves.

The importance of the study of history and of early narratives for the elucidation of points in physical geography will appear from the consideration of a few instances. Take, for example, the great and fertile basin of the river Ganges in India. The Sanskrit historian finds reason for the belief that in 3,000 B. C. the only habitable part of the alluvial plain of India was the water-parting or ridge between the Sutlej and the Jumna. The rest was a great estuary or arm of the sea. It has only been fit for man's occupation within the historical period, and hundreds of square miles of the delta have become habitable since the days of Lord Clive. The wonderful history of these changes can be traced by the student, who thus enables the geographer to explain the phenomena which he observes. Mr. Blanford, in his charming work on physical geography for the use of Indian schools, supposes a native of the country to be standing on the bank of the river that flows by his village, watching the turbid flood swirling past. The *chur* opposite, which the river left dry when its waters fell at the close of the last rainy season, and which, till lately, was covered by a rich green crop of indigo, is now more than half cut away, and buried beneath the water. Masses, many times larger than the house he lives in, from time to time detach themselves, and are swallowed up by the deep, muddy stream. If the Hindu ponders over what he sees he will perhaps be led to make inquiries, and old people will probably tell him that half a century ago the river itself was a moderate-sized *khall*, and that the old channel, seven or eight miles off, now little more than a string of pools, was at that time a great river. These facts and their causes will open to him an interesting chapter in physical geography; which is made more complete and more interesting by the ancient records of his people. But geography is an applied science. This body of facts and their causes is not a subject for mere speculative study only. It is of practical utility; for the knowledge of the way in which Nature has worked in past ages discloses her present and future operations, and enables the enlightened administrator and engineer to work in harmony with them.

Again, to pass to another part of the world. The student of history reads of the great sea fight which King Edward III. fought with the French off Sluys; how, in those days, the merchant vessels came up to the walls of that flourishing seaport by every tide; and how a century later a Portuguese fleet conveyed Isabella from Lisbon, and an English fleet brought Margaret of York from the Thames, to marry successive Dukes of Burgundy at the port of Sluys. In our times if a modern traveler drives twelve miles out of Bruges across the Dutch frontier he will find a small agricultural town, surrounded by corn fields and meadows and clumps of trees, whence the sea is not in sight from the top of the town-hall steeple. This is Sluys. A physical geographer will seek out the causes which have brought about this surprising change. They are most interesting, and most conducive to an intelligent comprehension of his science, and he will find them recorded in history. Thus the historian and the geographer work hand in hand, each aiding and furthering the researches of the other.

Once more. We turn to the great Baie du Mont Saint Michel, between Normandy and Brittany. In Roman authors we read of the vast forest called "Setiacum nemus," in the center of which an isolated rock arose, surmounted by a temple of Jupiter, once a college of Druidesses. Now the same rock, with its glorious pile dedicated to St. Michael, is surrounded by the sea at high tides. The story of this transformation is even more striking than that of Sluys; and its adequate narration justly earned for M. Manet the gold medal of the French Geographical Society in 1828.

Once again let us turn for a moment to the Mediterranean shores of Spain, and the mountains of Murcia. These rocky heights, whose peaks stand out against the deep blue sky, hardly support a blade of vegetation. The algarobas and olives at their bases are artificially supplied with soil. It is scarcely credible that these are the same mountains which, according to the forest book of King Alfonso el Sabio, were once clothed to their summits with pines and other forest

trees; while soft clouds and mist hung over a rounded shaggy outline of wood, where now the naked rocks make a hard line against the burnished sky. But Arab and Spanish chroniclers alike record the facts, and geographical science explains the cause.

There is scarcely a district in the whole range of the civilized world where some equally interesting geographical story has not been recorded, and where the same valuable lessons may not be taught. This is comparative geography.

The peasant of Bengal sees the mould falling into his turbid river, and learns the first lesson of a course which teaches him the history of the formation of the mighty basin of the Ganges. So should we, in England, to use the words of Professor Huxley, "seek the meanings of the phenomena offered by the brook which runs through our village, or of the gravel pit whence our roads are mended." Their meaning is equally significant, equally instructive, and it is thus that we should all begin to learn geography.

THE AGE OF ICE.*

By H. B. NORTON.

ANCIENT moraines, striations denoting the action of vanished glaciers, the lost rocks, clay beds evidently of glacial origin—all these are evidences testifying that at some period not very remote, as we count geological periods, the whole northern hemisphere down to the southern limit of 40° was submerged and covered with vast glaciers and ice-floes There is not a living scientist of any eminence who questions the truth of this assertion.

When we come to study the cause of these phenomena, we find many perplexing and contradictory theories in the field. A favorite one is that of vertical elevation. But it seems impossible to admit that the circle inclosed within the parallel of 40°—some 7,000 miles in diameter—could have been elevated to such a height as to produce this remarkable result. This would be a supposition hard to reconcile with the present proportion of land and water on the surface of the globe and with the phenomena of terrestrial contraction and gravitation. Moreover it seems evident that an extensive submergence was one of the features of the glacial age. The frozen archipelago called Greenland is a fair picture of what northern America and Europe must have been at that time; and, of course, this precludes the idea of elevation.

If it were not true that submergence and a great lowering of temperature occurred simultaneously, we might imagine that a sort of undulation in the earth's crust, alternately raising and lowering each portion of it, could have caused this result. However, there is no evidence that such an undulatory motion has ever occurred, and we cannot conceive of any force likely to produce it.

For the past fifty years, the relation of the inclination of the earth's axis to the plane of the ecliptic and its varying angle with the line of the apsides, has been the subject of careful study, from the impression that herein was a key to the mystery. Astronomical and geological works abound with hints and suggestions of this sort, but I have never yet seen any satisfactory analysis of the question. St. Pierre, Adhemar, and others have presented theories which seem strangely illogical in many of their conclusions. I have been striving to analyze the question, and will present a few of my conclusions.

The orbit of the earth is an ellipse, of which the sun occupies one of the foci. The major axis, or line of the apsides, is the longest diameter of the ellipse, passing through its two foci and through the points of perihelion and aphelion. This line is not fixed with respect to the other bodies in space. Owing to the attractive force of the other planets, it is slowly revolving in the same direction that the earth moves in its orbit. The rate of revolution of this line of the apsides or major axis is a little over 11·6″ a year.

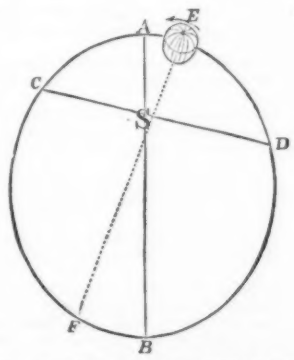
We ordinarily speak of the earth's axis as being always parallel to itself. It is, in fact, however, subject to a very slow gyratory motion, caused by the attraction of the sun upon the *meniscus*, or ring of matter bulging at the equator, which motion is retrograde, or in an opposite direction to the revolution of the earth. This retrograde motion causes the phenomenon known as the precession of the equinoxes. Its rate is about 50·3″ a year.

It will thus appear that a vast period of time will elapse before the earth's axis will occupy the same position with respect to the line of the apsides that it occupies to-day. This period is sometimes called the Great Year. Its length may be ascertained by reducing three hundred and sixty degrees to seconds, and dividing this quotient by the annual amount of the two motions described above:

$$1{,}296{,}000'' \div (50{\cdot}3'' + 11{\cdot}6'') = 1{,}296{,}000'' \div 61{\cdot}9'' = 20{,}937.$$

The Great Year is thus seen to be about 21,000 years in length.

I have here drawn a diagram illustrating the present position of the earth's orbit with respect to the line of the apsides, purposely exaggerating the eccentricity of the ellipse in order to better present it to the eye of the observer. In the diagram, A B is the line of the apsides; C and D are, respectively, the vernal and autumnal equinoxes; E F is the section of a plane passing through the poles of the earth at right angles with the plane of its orbit. It is evident that this plane will coincide with the line of the apsides once every 10,500 years; E is the winter solstice; F the summer solstice; C is the vernal equinox. While the earth is passing through B to D the north pole is inclined *toward* the sun. This period is the summer of the northern hemisphere.



A, Perihelion; *B*, Aphelion; *E*, Winter Solstice; *F*, Summer Solstice; *D*, Autumnal Equinox; *C*, Vernal Equinox.

D is the autumnal equinox. While the earth is passing from D through A to C, the north pole is inclined *from* the sun. This period is the winter of the northern hemisphere. In the southern hemisphere these seasons are reversed.

By consulting the diagram it will appear that the arc, C B D, is greater than the arc, D A C. Therefore, the summer of the northern hemisphere is now longer than its winter. On the contrary, the winter of the southern hemisphere is now longer than its summer. At present, this difference is about eight days. It has been greater, but is gradually diminishing.

The southern hemisphere has at present a winter of 187 days, and a summer of 179 days. We may justly infer that during this winter more snow and ice accumulated at the south pole than the heat of the shorter summer is able to melt. The amount of this increase is very slight in a single year, but it accumulates a large aggregate in the course of ages.

This accumulation of ice at the south pole is continually increased and thickened by the deposition of moisture from the atmosphere. Every wind from warmer regions that passes over it adds to its mass.

The "Antarctic Continent" is an ice-cap, nearly circular in form, and about 3,000 miles in diameter, unexplored and uninhabitable. We can not easily ascertain its thickness. The Arctic ice-cap is much smaller, and is honeycombed by the Kuro Siwa, or Japan Current, and the Gulf Stream. Nevertheless, the Greenland Archipelago seems covered with glaciers often several thousand feet in depth. If we could assign to the Antarctic ice cap a thickness of 15,000 feet, we should have a mass of ice large enough to displace the earth's center of gravity nearly a mile to the southward of its center. A gradual displacement of this sort, caused by the slow accumulation of ice, would produce an imperceptible drainage of the oceans from the north to the south, and the gradual emergence of northern and submergence of southern continents.

If we examine the globe, we seem to discover an actual result of this sort. The greatest mass of the ocean is gathered about the south pole. The northern hemisphere includes about five sixths of the land-surface of the globe. Moreover, geologists affirm that this inequality is increasing; they assert that the northern continents are slowly rising, and that the islands of the south Pacific are sinking. It is more probable that the water is slowly draining away from the northern hemisphere and accumulating in the southern. If our hypothesis be true, this process will continue for some thousands of years to come; until, through the submergence of southern lands and the extension of the Antarctic ice-cap, the condition of the southern hemisphere will approximate to that of the northern continents during their glacial age. Indeed, if the present position of the earth's axis with respect to the line of the apsides were invariable, we might expect to see a final complete submergence and refrigeration of the southern hemisphere.

But this position is not invariable. As I remarked above, it is slowly changing, making a complete revolution in 21,000 years. Refer to the diagram, and you will see that when F coincides with B, the winter of the southern hemisphere is longest; when F coincides with C, winter and summer in each hemisphere are of equal length; when F coincides with A, the summer of the southern hemisphere is longer than its winter The earth occupies successively all these situations during its great cycle of 21,000 years. Each hemisphere passes through alternate periods of a preponderance of summer or winter; each period being 10,500 years.

There is one more factor in this problem which must be considered, and that is the periodical variation in the ellipticity of the earth's orbit. Sometimes the line of the apsides is longer than at other times. This variation occupies regular but vast periods of time. It is evident that when the variation is greatest, the accumulation of ice at the winter pole must be most rapid.

The 10,500 years during which the pole is refrigerated and deluged, may be called its great winter; the other half of the cycle, its great summer.

Unless astronomical calculations fail, the last great summer of the northern hemisphere commenced some 6,500 years ago. When it began, northern America, Europe, and Asia were frozen and deluged. The Arctic Ocean extended to a line south of the present bed of the Great Lakes. The Alps and the Alta were also southern boundaries of this ocean. Europe was the home of a swarthy, dwarfish race, who hunted the aurochs and great hairy mastodon at the foot of the glaciers that then half overflowed the continent.

But the intenser suns of many ages have done their work. The glaciers have melted, dwindled, retreated to the high Alpine valleys, and to the high northern latitudes. The swarthy troglodytes and lake-dwellers have followed them. Under the name of Esquimaux, Lapps, and Finns, a feeble remnant of these preadamite people still lingers within the Arctic Circle; but their doom as a living race seems near and sure. The Aryans have come marching across the Eastern steppes, for the building of society, civilization, human history.

In the outset of this argument, I assumed an Arctic ice-cap 15,000 feet in thickness, and a displacement of the earth's center of gravity one mile toward the north at the height of the glacial age. In fact, it is not necessary to assume any such amount of displacement. If the earth's center of gravity coincided with its center, so as to equalize the amount of water in the northern and southern hemispheres, Itasca Lake would not be more than 600 feet above sea-level. Now push the center of gravity 2,000 feet toward the north, and the Arctic Ocean would be so much deeper over the pole, and the water would be about 1,000 feet deeper at the latitude of 45°. To accomplish this result, we must calculate that the space within the Arctic Circle was covered by an ice-cap averaging perhaps 8,000 feet in thickness—an entirely supposable case. Such an amount of displacement would flood all the low lands of North America down to the line of 40°, and fully satisfy all the conditions of the problem.

It thus seems probable that there have been many glacial periods in each hemisphere, and that the ocean, like a mighty pendulum, vibrates from pole to pole through vast but regular periods. It is not necessary to suppose a cataclysm at the end of each period, as some of the earlier writers did; but rather, an insensible drainage of waters, which so gradually submerges the lands and pushes the human race before it, as hardly to be perceptible in the course of generations; ever uncovering new continents, and opening up fresh fields and pastures new to human industry, when the old are exhausted.

The southern hemisphere is now undergoing the slow refrigeration of its long winter. This began about 6,500 years ago; it will end about the year 4870. It has passed its middle, but not its culmination, even as the greatest average cold of our ordinary winter is nearer the vernal equinox than the winter solstice. It is probable that, 2,000 years from now, the southern continents will be still more deeply deluged; the Antarctic ice-cap will have extended several hundred miles to the northward, and the glaciers which have already appeared among the Andes will have covered the plateaus of Patagonia and Chili. Nevertheless, we need not expect that mankind will then witness the utmost possible degree of refrigeration, because the ellipticity of the earth's orbit is now less than it has been at certain periods in the past, and will be again in the remote future.

I feel that, in this discourse, I have ventured upon doubtful and perilous ground. Nevertheless, however illogical and imperfect my conclusions may have been, I feel certain that herein is the key to the mystery. I leave the question, trusting that abler minds may be directed to its consideration and solution.

* From a lecture delivered before the Kansas Academy of Science.

[Continued from SUPPLEMENT No. 188, page 2998.]

Translated from *La Correspondance Scientifique*.

THE BEGINNING AND END OF THE WORLDS.

By CAMILLE FLAMMARION.

III.

THE RESURRECTION.

WE left the earth frozen and depopulated by cold, the last family sleeping its last sleep, the sun progressively obscured by the formation of a solid crust around him, the planetary system in its entirety thereafter deprived of the light and heat which would have caused it to live so many ages; and where we left off, we saw the sun, as an enormous black ball, continuing his route in space, carrying around him his dark planets—deserts, ambulant tombs continuing to gravitate about him in eternal night. What is to become of these worlds? Matter, like force, being indestructible, will they continue to gravitate eternally in space, in the state of cosmical skeletons? To answer this question we are obliged to leave the domain of pure science and enter into that of hypothesis. But even here, let us try not to forget the rigorous principles of the method of scientific induction.

If such was the definite end of the worlds, if the worlds should die forever, if the suns once extinguished should never be relighted, it is probable that there would be no more stars in the heavens. And why?

Because creation is so old that we may consider it as eternal in the past. Since the time of their formation, the innumerable suns of space have had fully the time to become extinguished. Relatively to past eternity, it is only the new suns that are shining. The first are extinct. The idea of succession forces itself on our mind in spite of us.

It is impossible to admit the old theory of a creation made once for all. The very idea of God is synonymous with the idea of Creator. As soon as God exists he creates; had he created but once, there would no longer be any suns in immensity, nor planets gathering around them light, heat, electricity, and life. Creation must of very necessity be perpetual. And, moreover, let us interrogate Nature directly, and let us listen to her answer.

What is taking place around us? The same molecules of matter are successively entering into the composition of different bodies; the bodies change, matter remains. In the interval of a month, our own body is almost entirely renewed. A perpetual change is in operation between the air, water, minerals, plants, animals, and ourselves. The molecule of oxygen which escapes from the worm-eaten trunk of yon old oak in ruin, goes to incorporate itself in the blonde head of the new-born infant, and the molecule of carbonic acid exhaled from the oppressed breast of the moribund individual stretched out on his bed of suffering, goes to blossom again in the perfumed heart of the rose in the garden. The atom of carbon which is now burning in our lung, may perhaps have also burned in the candle that Newton used in his optical experiments; and perhaps at this very moment you have in your hand certain atoms that once belonged to the charming arm of Cleopatra or the head of Charlemagne. The molecule of iron is the same whether it circulates in the blood which palpitates in the temple of an illustrious man, or that it lies in a mean fragment of rusty iron. The molecule of water is the same whether it shines in the loving glance of the *fiancée*, or that it intercepts the rays of the sun in a monotonous cloud, or that it is precipitated in a thunder-shower upon the earth. Incessant exchange during life; exchange none the less rapid after the death of organisms. The matter of beings does not remain at rest, but re-enters into the circulation of life. What we breathe, eat, and drink, has already been breathed, eaten and drunk thousands of times. We are composed of the dust of our ancestors. If all the human beings who have already lived on the earth should return to it, there would be five of them to every square foot of soil, and they would be obliged to climb one on top of another to stand erect on the surface of the continents. But they would not be able to come back again in their entirety, since the same elements have belonged to several bodies.

That is what is taking place around us. Now there is neither great nor small in nature. The stars are the atoms of infinity; the laws that govern atoms also govern worlds. The same quantity of matter always exists. After having been used in forming nebulæ, suns, planets, and beings, it does not remain inactive, but enters into a new circulation; otherwise the world would end. Otherwise the day would come when all the worlds would be dead, buried in night, rolling, falling without aim in the desert blackness of space—an eternal solitude that no ray of light would ever again illumine. This is a prospect which gives no satisfaction to the most elementary logic.

But by what natural process may the dead worlds again become living ones? When our sun shall become extinct (and there is no doubt that he will be in the future), how will he re-enter into the circulation of eternal life?

The study of the structure of the universe, which is as yet but scarcely begun, allows us to propose two answers to this question; and it is probable that Nature, who gives up her secrets so charily, holds others that are still better in reserve for the science of future ages.

Two dead globes may revive and recommence an entirely new era in reuniting, by virtue of the simple laws of gravity. To gain a clear idea of this, let us suppose that a dark globe as large as the earth, or as large as the sun—it is of lit-

tle consequence, be launched into void. It carries with it its active force; and if it is alone in space, it will continue to move on in a straight line, always with the same speed, with no power to check it or accelerate it, nor to turn it aside one *iota* from its trajectory, and it will go on thus eternally. The force which animates it will always be employed in causing it to pass over the same number of feet per hour But let us suppose now that just there at the goal toward which it is moving, and in a direction diametrically opposite, there is another ball of the *same mass* that is projected toward the first with the *same speed*. When the two reach each other they will naturally clash together and stop short. What will become of the force which actuated them, since there is nothing lost in nature? It will be transformed, and the motion, until then visible, will become an invisible motion, exactly of the same intensity as the former, and which, putting in vibration the constituent molecules of the two masses, will separate them, and create a burning and dazzling sun out of the two cold and dark globes.

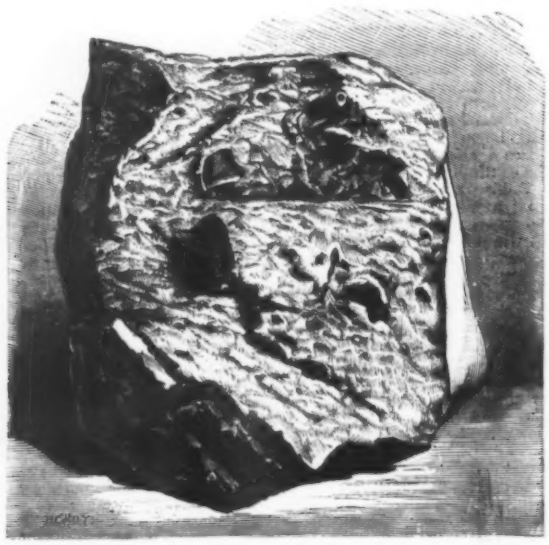
The hypothesis that we have just made would be realized of itself, without obliging us to project the two globes against each other, simply by placing two globes in space at any distance whatever apart. By virtue of the laws of gravity, they would slowly direct themselves toward each other, and inevitably succeed in uniting with a dazzling clash that would transform them into a sun, and even into a nebula.

Let us suppose, for example, that our sun and the star *Sirius* were the only suns existing in infinity. By virtue of the laws of gravity, they feel each other through space and solicit one another. Scarcely placed in void, they tend to approach one another. The movement is at first infinitesimal. During the first day, they would move toward each other only the fraction of a second. That is imperceptible; but the movement goes on increasing. At the end of a year the approach will have become perceptible; here we see them rushing toward each other like our two balls above mentioned; and after two millions of years of incessant movement, one will be precipitated into the other with such speed that they will unite, melt together, and evaporate into a single immense and brilliant nebula.

(*To be continued.*)

A NEW METEORITE.

THE collection of meteorites of the Museum of Natural History at Paris has just been enriched by a new specimen of considerable interest, and which is represented half actual



METEORITE WHICH FELL OCTOBER 13, 1877, AT SOKO-BANJA, SERVIA. (HALF NATURAL SIZE.)

size in the accompanying engraving in its general characters. It is one of a number of stones which fell on the 13th of October, 1877, at about 2 o'clock in the afternoon, at Soko-Banja, to the northeast of Alexinatz, in Servia. According to an eyewitness, the weather was fine at the moment of the occurrence, and the sky clear. All at once a noise like a succession of artillery discharges was heard, and the air was violently disturbed. Then began a fall of stones, the largest of which, weighing 30 ohas or 67½ Austrian pounds, landed at Scherbanowaz near Rtanj Berg.

According to the peasants, another one, "as large as a bag of flour," fell at the same point, but was reduced to powder on contact with the rocky surface. The total weight of the stones is estimated at 175 pounds.

As the result of an investigation made on the spot by the scientists of Belgrade, it seems that two explosions like a volley of firearms were heard, while at the same time a light appeared more brilliant than that of day. A dense black smoke was seen at a considerable height, dividing into three columns, and which was gradually replaced by a thin white smoke.

After this quickly came the meteorites in great number, spreading themselves over a surface of country one and a half miles in length by a half mile in breadth. From the data furnished by observation it is calculated that the explosion occurred at a height of about 4 miles. The trajectory of the meteor made an angle of 220° 50' with the magnetic meridian, and was directed from northeast to southwest. Specimens of the Soko Banja meteorite, having been sent to the Belgrade Museum of Natural History, were there submitted to a chemical analysis. It is an ash-gray rock of extremely remarkable structure, the general mass consisting of a sort of paste formed of small grains, in which are embedded polyhedral flint-like fragments. This is very well shown in the engraving. It contains also a grass-green pyroxenic mineral having the appearance of sahlite, and which does not appear to have been remarked by the Servian scientists. Notwithstanding its strange appearance, this meteorite does not constitute a new type, but is exactly the same as the Manbhoomite described by Meunier in 1870 as a distinct lithologic species. Its analogue is found among the natural rocks in the trachytic tufas, known under the name of *trass*, and which are so abundant in Auvergne and on the banks of the Rhine. This resemblance, however, is entirely physical, trachyte being an aluminous silicate, while the meteorite consists of a mixture of magnesian silicates. But it speaks none the less eloquently of the mode of formation of the cosmic mass, since it demonstrates the successive play of geological actions exactly like those of which our own rocks are the product. It is, indeed, manifestly impossible that the mass has assumed this complicated structure all at once; rocky strata must necessarily have been first formed, and these have been submitted to crushing action and friction which have reduced them to small fragments. Moreover, these various fragments not being identical with each other, the original elements of the primitive strata must have been conveyed to a common point, perhaps through explosive actions analogous to the volcanic eruptions which mix up various materials, aggregated or otherwise, in their ashes. Finally, when the Soko-Banja conglomerate is closely examined, we find that subsequent to the mixture of the earthy elements of which it is formed, a metallic cement composed of an alloy of iron and nickel has insinuated itself in small quantities into the fissures and bound together all portions of the breccia. Now this again presupposes geological actions, which may be compared with those which take place on the earth in volcanic regions and in metalliferous veins. The latter conclusion is the more certain, as it is founded upon direct experiment. In a series of memoirs read by M. Meunier before the French Academy it has been shown in fact that it is possible to cement together rocky fragments with definite alloys of iron and nickel, by heating them, in the presence of the chlorides of these two metals, in an atmosphere of hydrogen. The result of this experiment can be accepted as a reproduction of the natural fact, since we have proof that the majority of meteoric irons have been produced by the reduction of metallic chlorides under the influence of hydrogen. Indeed, it happens in cutting blocks of the cosmic metal, that we find therein small crystals of protochloride of iron, representing a residue of the formative materials; and a meteoric iron cannot be heated in a vacuum without extracting from it much occluded hydrogen.

One of the consequences of the mode of formation of tufas like those of Soko-Banja is, that the medium from whence meteorites are derived was relatively extensive, and that geological actions had place therein like those that have occurred on our own globe. Moreover, the metallic reductions just mentioned, and the celebrated experiment of Gay-Lussac on the specular oligiste of volcanoes, differ simply in the oxygen, absent from the first and present in the other. This difference, in adding a new term to the series of comparisons instituted between cosmic rocks and the masses forming the crust of the earth, gives still another evidence of the grand unity of geological phenomena in our solar system.

HOW TO EXPLORE FOR MINERALS.

MR. J. E. CLAYTON, mining engineer, contributes to the Salt Lake (Utah) *Tribune* the following items on prospecting for minerals:

1. Examine the gravel and bowlders of the mountain streams, and note carefully the structure and character of the gravel wash. This will reveal the geological formations that are intersected by the stream. Try the sands at the head of the gravel bars for free gold, or for any crystallized minerals, etc. If the structure of the quartz bowlders or other vein stones is favorable, go up the stream until the geological zone is found that has produced the quartz or other metal-bearing minerals. Then follow the supposed metal-bearing zone on its line of strike, and make especially careful examinations wherever eruptive dikes are found intersecting the formation.

2. When a lode or vein is found, note carefully its relation to the country rock, especially any differences in the opposite walls of the vein. Then follow it on the line of outcrop, and note carefully those points where the best ores are seen, so as to determine the position of the best ore chutes before making any location on the lode.

3. The first work should consist of shallow cuts across the lode at intervals of 50 to 100 feet, or, if the vein is small and partially covered by soil and débris, a trench along the line of outcrop is preferable. If the surface tracing is satisfactory, and the true line of strike has been determined, then survey your claim, and stake off the boundaries according to the requirements of the United States laws.

4. The work of exploring the vein underground is the next thing in order. To do this intelligently, you must select that point on the line of the outcrop where the best ore is found, then sink a shaft on the lode, following the angle of dip, keeping both foot wall and hanging wall exposed if possible. If the lode is too wide for this to be done, then follow the best ore streak of the vein itself, and at every fifty feet in depth make cross cuts to the walls of the vein. After 100 feet deep has been reached, run levels each way from the shaft on the line of the vein, in order to determine the extent or spread of the ore-chute or chimney on the horizontal line. When the limit of the ore body on the horizontal line has been ascertained, then sink 100 feet more, and drift right and left as before. If more than one chimney of ore is found on the line of the vein, a shaft should be sunk on it and drifts run as above stated, being careful to confine all the exploring work within the walls of the vein itself. When enough has been done to prove the character, size, and quality of the vein, it will then be time to determine the position, character, and extent of the "dead work" necessary to work the mine to the deep. These questions should be settled by careful surveys, made in the light of all the local facts and surroundings, such as the geological structure of the country rock, the probable amount of water to be raised, the lowest point of drainage by adit or level, and the most convenient point for delivery of the ores to the surface, etc.

The last part of the preliminary exploration of any mine is to determine, by actual tests, what are the best methods of reduction, and the extent and kind of reduction works needed, etc.

5. After all these preliminary facts have been thoroughly ascertained and clearly defined, the unavoidable risks of mining will have been fully met and overcome. All subsequent operations are simply matters of skill and business management, and the capitalizing of the mine becomes a mere matter of business detail.

The requirements are as follows:

1. The preliminary exploration must have ore enough cut and underrun, or otherwise exposed, to give at least two years' work for reduction works of an extent sufficient for the average annual output of ore.

2. The reduction works must be suited for the best treatment of the ore.

3. The exploration of the mine must be pushed ahead of extraction of ore, so as to expose at least one ton of ore in new ground for every ton extracted from the previously explored ground.

4. Before erecting reduction works, the ore exposed in the mine should be so thoroughly tested as to guarantee a net profit sufficient to pay the whole cost of such works.

5. The mine being well opened, and the reduction works, or plant, established, the general success of the enterprise must depend upon the efficiency of the general business management.

THE SOUTH PASS JETTIES.*

NOTES ON THE CONSOLIDATION AND DURABILITY OF THE WORKS, WITH A DESCRIPTION OF THE CONCRETE BLOCKS AND OTHER CONSTRUCTIONS OF THE LAST YEAR.

By MAX E. SCHMIDT, C.E.

IN presenting this paper to the society it is not my intention to discuss the question whether or not jetties have been the proper means by which to improve navigation at the mouth of the Mississippi.

A few explanatory remarks to accompany the chart of the last channel survey, and one or two tabular statements giving in a condensed form the results that are of interest, will enable a dispassionate judgment to be formed as to the efficiency of the improvement.

A year ago a paper was read before the Tenth Annual Convention of this Society by Mr. E. L. Corthell, the Resident Engineer, wherein he says:

"It will be remembered that the jetties are still incomplete; that the results aimed at are not yet fully realized, and that many of the phenomena are the results of progressive works, and are incidents simply of the progress of channel making, at which the river has been set at work."

To-day, in reviewing the rapid progress which has been made in the construction of the jetties and in the improvement of the channel during the last year, we can promise the speedy completion of the work.

My object is to present some plans finally determined upon to insure permanency to the works, to explain the causes that led to their adoption, and to speak of the degree of durability attained in the construction of the jetties.

In doing so, I shall endeavor to make my remarks as comprehensive as possible by referring largely to illustrations.

INTRODUCTORY NOTES OF INTEREST.

1. The East Jetty begins at the old eastern land's end, and is eleven thousand eight hundred (11,800) feet long.

2. The West Jetty begins four thousand (4,000) feet below the eastern land's end, nearly opposite the western land's end, and is seven thousand eight hundred (7,800) feet long.

3. The Kipp Dam, six hundred (600) feet long, connects the head of the West Jetty with the west shore, and will be treated as a part of that jetty.

4. The jetties are one thousand (1,000) feet apart, and run parallel with each other.

5. The wing dams project out one hundred and fifty (150) feet from each jetty, and are of a temporary nature generally.

6. Both jetties terminate just beyond the crest of the old bar, two and one-quarter miles seaward from the old eastern land's end.

7. The jetties are built of willow mattresses and stone.

8. Both jetties, excepting the lowest, one thousand (1,000) feet, may be considered permanently raised to the level of average flood tide.

9. The top of the mattress work where brought to the surface is twenty feet wide and covered with a layer of stone about one foot in thickness.

10. Tides are diurnal, and rise one and one-half feet.

11. The prevailing winds blow from an easterly direction.

12. The mean velocity of the river current during flood stages of the Mississippi is three miles per hour.

13. During the low water stage the current decreases to three-fourths of a mile per hour, and reverse currents have been observed

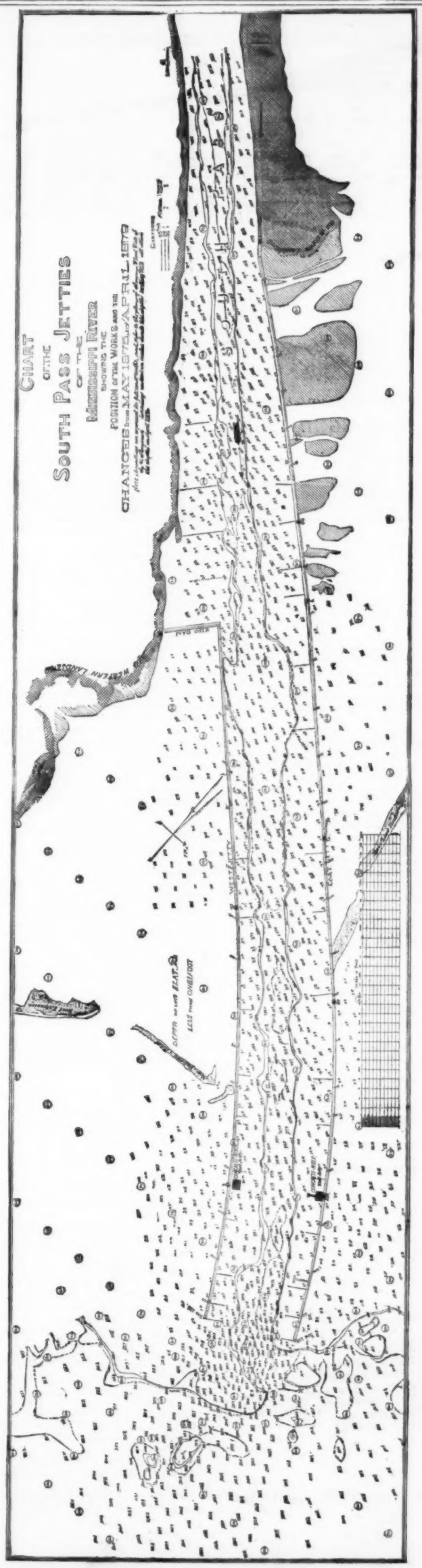
14. Gales and hurricanes are liable to happen during the equinoctial months; highest velocity of wind observed, seventy-two miles per hour.

I.

Abstract of Plans and Specifications for Consolidating the Jetties at the South Pass, adopted and work commenced November, 1879.

The East Jetty to a point eight thousand feet and the West Jetty to a point nine thousand feet seaward, mea-

* Read at the Annual Convention of the American Society of Civil Engineers, at Cleveland, O., June 17, 1879.



sured from the eastern land's end, to be finished by a rounded paving of rip-rap stone on the top of the mattress work.

The center of the pavement to follow the center line of the jetty, the crest to be at the level of one and one-half feet above average flood tide, and the base to be twenty feet wide.

The stones to be set on edge as far as the lowest stage of the tide permits. The submerged part of the slope on the river and sea side to be built of rubble stone with an inclination of two to one.

In order to prevent leakage, gravel to be worked into the mattresses, and the top to be generally leveled up before proceeding with the paving.

Macadamized stone to be used to fill out the interstices between the larger stones composing the capping, and the slopes to be tightened in a similar manner by a liberal application of gravel and broken stone. No willow work to be visible, and the jetties to appear as though they were built of stone. On Plate I., next page, may be found a section finished in the contemplated manner.

The remaining distance of both jetties, namely, three thousand eight hundred feet of the East Jetty and two thousand eight hundred feet of the West Jetty, to be consolidated by large blocks of cement concrete placed on top of the jetty. The blocks to be from sixteen to twenty feet long, from five to thirteen feet wide, and from two and one-half to four feet thick, the dimensions enlarging by off-sets as the jetties approach the sea ends.

The bottom of these blocks when put into position to rest at the plane of average flood tide, the jetties to be leveled up to that plane by large and small stone and gravel.

The blocks to serve as a foundation for a superstructive parapet, to be composed of concrete, and continuously built, from three to six feet wide and from two and one-half to four feet high.

This parapet to be applied to the lower sixteen hundred feet of both jetties.

A sufficient period of time to be allowed for the foundation blocks to settle before grading and leveling up preparatory to the construction of the parapet.

From the upper end of the concrete work to a point six hundred feet above the extreme sea end, the river and sea slopes of both jetties to be composed of rubble stone, intermixed with macadam stone and gravel. The slope to be built with an inclination of two to one.

A rounded cap of paved stones to be carried from half the height of the concrete foundation blocks to the lowest attainable water's edge.

For the lower six hundred feet of both jetties the sea slope to have a foundation, composed of a willow mattress, one hundred feet wide and two feet thick. On this foundation a sloping crib work to be placed, composed of palmetto piles, to be sunk by filling the compartments with large stones averaging about one ton in weight.

On the river side a similar crib work to be sunk on the rip-rap foundation already in place.

The vertical edges of the cribs to face the jetty and stand at a distance of from ten to fifteen feet from the embankment—the intermediate space to be filled with stone. Large rock to be used for covering the crib and making the connection with the concrete blocks on the jetties.

On Plate II., Figs. 1, 2, 3, may be found an exhibition of the contemplated work.

The pier heads, at the extreme end of both jetties, to be built at right angles to the axis, and in form of a T-head, to extend out on each side of that line. The foundation on the East Jetty to be one hundred and eighty feet wide and on the West Jetty seventy-two feet wide. As the surface is neared, the structure to contract so as to make the forward and side slope descend pyramidically into the Gulf, the foot of the slope on the East Jetty to rest one hundred feet seaward from the last concrete block. On the West Jetty the slope to project thirty-five feet.

In constructing this part of the work the area in advance to be leveled up by mattress work to a depth of sixteen feet below average flood tide, and thence raised to the surface by palmetto crib work held in place and covered with large stones.

The plans are subject to such modification as development of results may suggest.

II.

On the Degree of Durability Attained in the Construction of the Jetties, with an Explanation of the Causes that Led to the Adoption of the Plan Toward Consolidation.

It will readily be understood that if these works have been as successful as it is claimed in deepening the bar at the mouth of the Mississippi from nine and two-tenths feet to twenty-seven and two-tenths (27·2) feet, the question of their permanency must necessarily arise and involve the present and future value of the jetties.

The term "permanent" applies to all things that preserve and maintain the properties with which they have come into existence.

Strength being superlatively the original aim in the construction of sea work, *continuous* strength must be the essential for their permanency.

Hence it is obvious that the value of sea works will be proportional to the degree of strength which they possess, and, again, that any shortcoming on the part of the works, to fulfill the duties imposed, will be traced back directly to imperfections and defects in the mode of construction.

This mode of construction in the case of the South Pass Jetties has been a study in itself, as will be seen presently.

There were three destructive elements to be overcome by these works:

1. The abrading power of the river current.
2. The momentum and impact of the waves.
3. The undermining power of the waves.

With a full appreciation of the magnitude of these forces, no design was made, nor was any detail allowed to be put into the works, which did not strictly adhere to the following practical laws:

1. That a broad and elastic foundation will prevent undermining.
2. That proper slopes will resist the impact of the waves.
3. That tight work will stop leakage, and
4. That work maintained at a uniform height will obstruct the escape of water by overflow.

In these four points, or rather in their homogeneousness, lies the secret of permanent work.

The peculiar conditions under which this work has been carried on, and the many embarrassments and disadvantages which surrounded it from the start, are facts which have been well known

At this place, and bearing upon the subject treated in this paper, I will only say that, as a matter of necessity, the execution of the works had to be governed in more than the

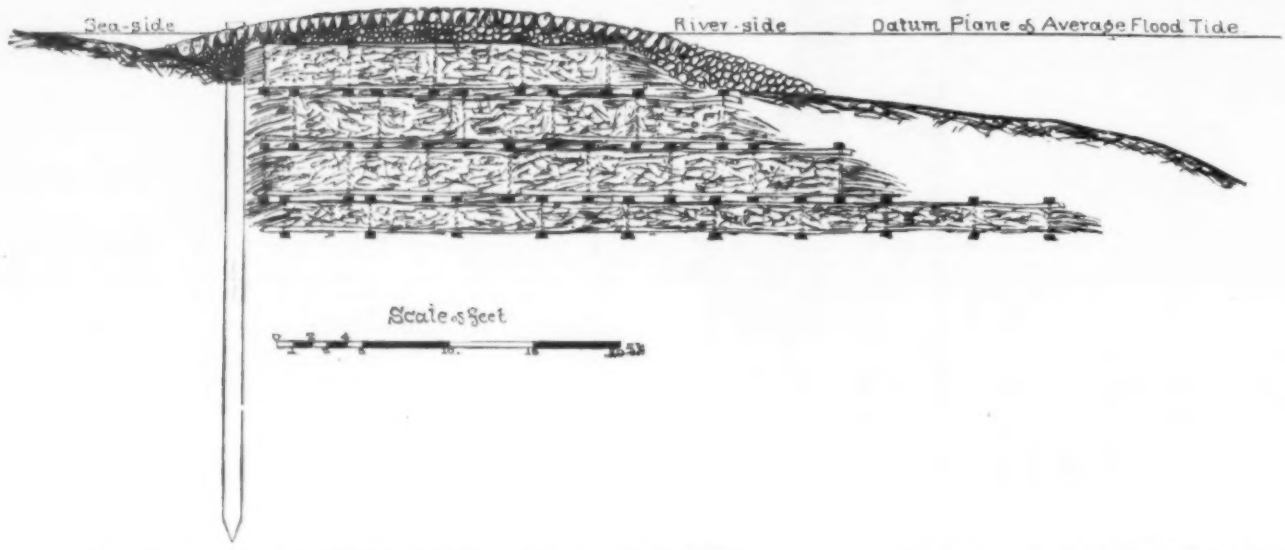


PLATE I.—SECTION OF JETTIES BETWEEN EAST POINT AND 8,000 RESP. 9,000 FEET SEAWARD. FINISHED ACCORDING TO PLANS.

ordinary sense of the word by rapidity and economy, leaving it for a future day to add such appliances as experience would suggest to maintain the strength of the works. The day to do this has arrived, as will be seen from the plans accompanying this paper. They are the results of a long experience, a careful study and searching investigation of the phenomena which prevail in this locality.

In this connection it should be remembered that four years ago to-day, on the 17th of June, 1875, the first pile was driven in the work, and, a month later, the first willow mattress sunk close to the eastern land's end at the mouth of South Pass.

To-day the willow work may be regarded as completed, and the progress made toward consolidating the jetties by the application of heavier material has advanced far enough to foretell the period when this work will be completed, to stand an enduring monument of the capabilities of our profession.

During the construction of the mattress work the ratio of stone to willow was 1 : 5·32. This ratio may appear to be small, but it was found to be sufficient, as will be explained further on.

The specifications of the willow contract demanded flexible branches not exceeding two inches in diameter at the butts. The willows were brought a distance of about twenty-five miles. They grow in abundance along the banks of the Mississippi, above the head of the Passes, and overspread the small sub-deltas which have formed by deposits of the river at crevasses and lateral outlets where the waters have left the main stream and made a shorter road to the Gulf.

The willows were, therefore, easily obtained, cheaply transported, and were a material which, on account of its light weight, caused little wear and tear to the barges on which it was loaded.

Not so with the stone. The singular geognostic condition of the delta, followed by the total absence of rock for many hundred miles inland, made it a problem from the beginning how to procure the rock in quantities large and fast enough to allow the prosecution of the works with economy and rapidity.

During the early stages of the work some rock—among which there was much granite—was obtained in New Orleans from the ballast of foreign ships. There were secured from this source nearly twenty-one thousand tons, brought from all parts of the world.

But under the pressure of incessant demand this supply soon became exhausted, and for a while rock was obtained from quarries near Vicksburg, Miss., five hundred and fifty miles distant from the jetties. This rock, however, did not answer. It contained a high percentage of loamy sand, and was brittle and permeable. The plan of drawing the supplies from that source was, therefore, soon abadoned.

The present contractors, Messrs. J. Sharp McDonald & Co., of Pittsburg, Pa., bring the stone from quarries in the limestone region near Roseclair, on the Ohio River, thirteen hundred miles above the mouth of the Mississippi. The rock here is composed chiefly of calcareous, intermixed with quartzose elements, and has been found to possess fully the requirements of hardness, strength, and weight to make it serve the purpose for which it is intended. Weight, per cubic foot, 155½ lb.

Rock, in any shape or size as it may be desirable for a special operation at the jetties, is furnished by the contractors in two monthly tows of about twenty barges, each barge containing an average of four hundred cubic yards of rock.

The preservation and care of the property destined for the construction of the works has been an item of great importance from the beginning, directly concerning the progress and often the safety of the works.

During the earlier stages, while the whole line of the works was much more exposed to the "abrading power of the current" and the "momentum and impact of the waves," it was a matter of unquestionable importance to always have the two materials, willows and stone, in readiness for immediate use in case damaged portions of the works needed repairing. A delay would cause tenfold the outlay of money.

The great aid which nature extended to these works in adding strength to them from its own sources (see deposit on sea side, Figs. 1 and 2, Plate III.), was essentially hastened by uniformity in construction, which caused a uniform degree of tightness throughout and equable resistance to destruction.

While nobody will deny that a more liberal application of stone from the beginning might have hastened the formation of the channel, since it would have made tighter work quicker, we can unfailingly pronounce the saving in that quarter to have resulted in furnishing valuable data on the strength and dimension of cross section required to resist the current of the Mississippi and the waves of the Gulf.

Under more auspicious circumstances, if, for instance, the whole amount of money appropriated for this enterprise had been available at the commencement of the work in June, 1875, precautional measures might have been resorted to, consisting chiefly of greater area of pier section, which, although perfectly legitimate, would have been superfluous, as is shown by the course of events during the four years of jetty construction.

This point is illustrated by Figs. 1 and 2 on Plate III. Fig. 1 shows the manner in which it was intended to finish the pier section at a point four thousand two hundred feet seaward from the eastern land's end, while Fig. 2, which gives the actual condition in which the jetty is built, enables us to compare the two. It should be stated that the foundation mattress on the sea side for a distance of three thousand feet was sunk under misconstruction of orders. No human engineering could have constructed a more sheltering protection than that which is obtained by the deep deposit of sand which has accumulated on the sea side over an area of many hundred feet in width, skirting both jetties in their march over the crest of the bar.

In explaining the causes that lead to so vast a deposit of sedimentary matter, the order in which the construction of the jetties was carried on furnishes the best criterion.

It will be remembered that the entire length of the foundation of the jetties, from the land's ends to sea ends, was laid before the second tier was applied; and again, that the entire second tier was placed and sunk on the foundation before the third tier was commenced, and so forth, until the surface was reached.

The jetties have therefore been raised with a uniform degree of vertical progress over their entire length.

In doing this, it was observed that each tier of mattresses causes a shoaling on the sea side corresponding in height with the thickness of the mattresses in place.

This was due to the obstruction which was placed in the way of each successive layer of current, stopping the flow sufficiently to cause the sediment to precipitate on the other side.

As the jetties grew up, and commenced to confine the volume of the pass, the water was largely charged with additional sediment due to channel erosion. But, by limiting the potency of the current to the channel between the jetties, no suspending power existed to carry the load of sediment over that portion of the bar which was not jettied.

It was dropped, therefore, on the crest and on the landward slope of that bar, building up a chain of successive reefs, as the bottom neared the surface. New Pelican Reef, Baseline Reef, and Reef Extension (see Chart of Channel) are such new formations.

The numerous advantages of the sea side deposit were fully appreciated, and measures taken to induce by means, based upon the same laws, a similar deposit on the river side.

For this purpose a system of wing or spur dams was built, each wing dam jutting out one hundred and fifty feet from and at right angles to the main line of the jetty. Although rapidly constructed, and with no view to permanency, these wing dams have been most effective in giving protection to the jetties and hastening channel erosion. The current is stopped above and below the dams, the sediment drops, and a bank forms.

On plate IV. are two comparative sections of the channel between the jetties, Fig. 1 showing the condition before, and Fig. 2 the condition after the wing dams were built. The effects are plainly visible.

The channel between the jetties, although intended to be one thousand feet, is at present only about seven hundred feet in width; but while the channel depths are allowed to increase in proportion to the greater contraction of the channel way, the jetty embankments are removed behind a sheltering bank of deposit which is braced and stiffened, as it were, by the tilted mattresses composing the wing dams.

Of the entire length of the jetties all but the last two thousand feet at the extreme sea ends have received these protective deposits on the river and sea side.

FIG. 1.

SECTION, 9000 FT SEAWARD FROM EASTPOINT.

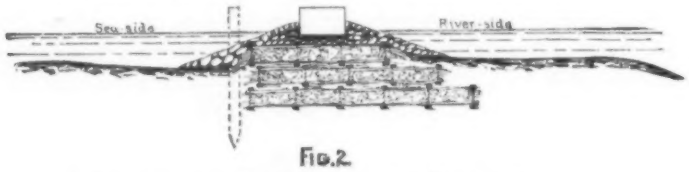


FIG. 2.

SECTION, 10400 FT SEAWARD FROM EASTPOINT.

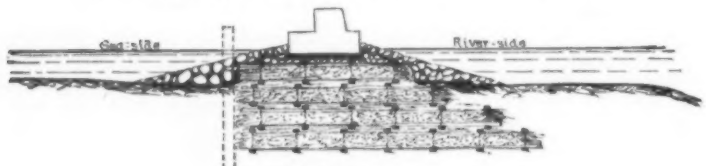


FIG. 5.

SECTION, 11800 FT SEAWARD FROM EASTPOINT.

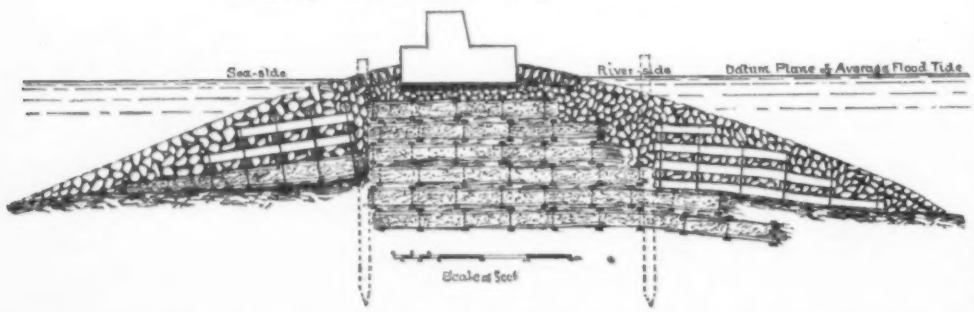


PLATE II.—SECTIONS OF THE LOWER PARTS OF THE JETTIES. FINISHED ACCORDING TO PLANS.

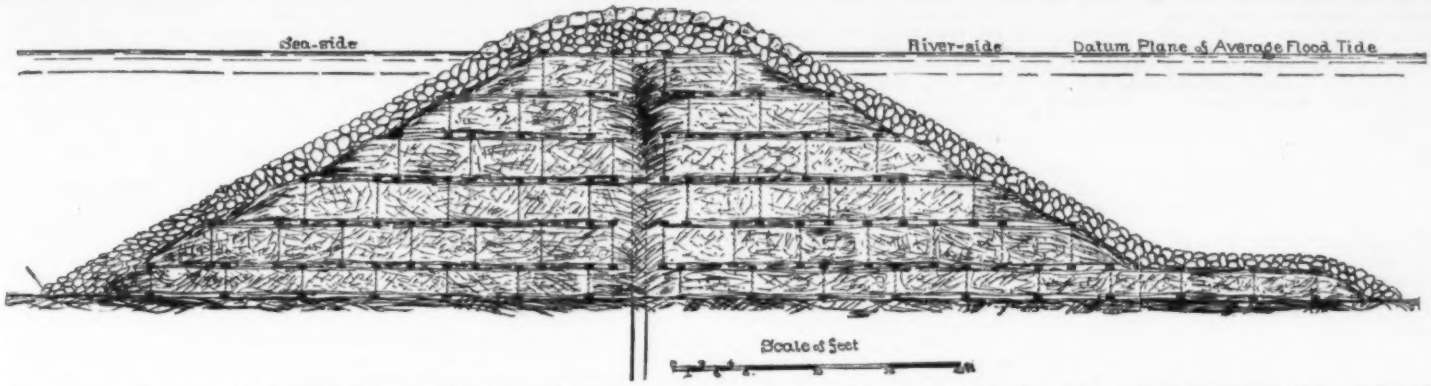


PLATE III.—FIG. 1.—SECTION OF WEST JETTY AS ORIGINALLY PROPOSED, 4,200 FT. SEAWARD FROM EASTPOINT.

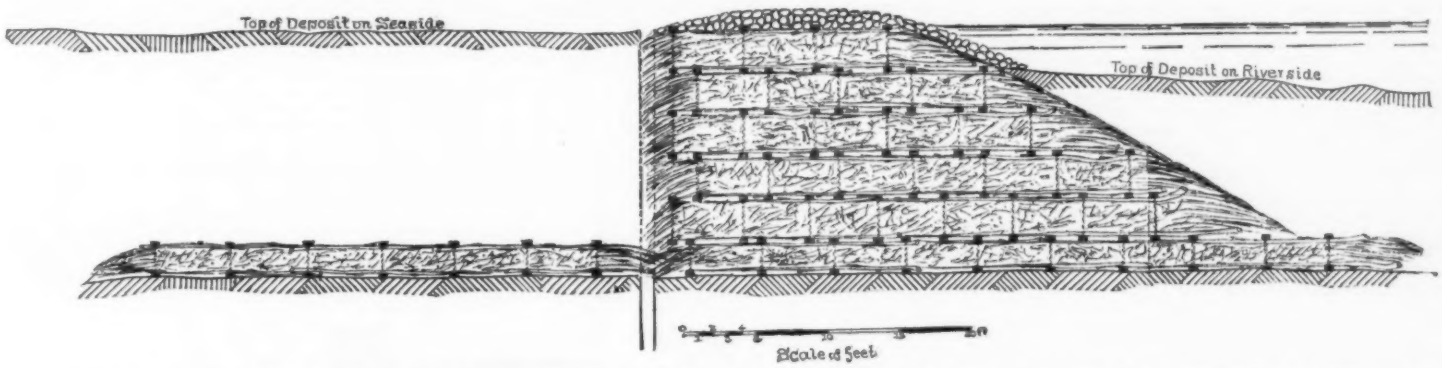


PLATE III.—FIG. 2.—SECTION OF WEST JETTY AS CONSTRUCTED 4200 FT. SEAWARD FROM EASTPOINT, SHOWING PROTECTING DEPOSIT ON SEA AND RIVERSIDE.

It is evident from the plates and drawings presented that ninety per cent. of the willow work composing the jetties is immovably bedded in the deposits of the river.

No such thing could have come to pass if the water of the Mississippi did not contain the vast percentage of sedimentary matter which it carries to sea annually. But in such a case there would have been no delta, no bar, and no jetties. Thus, the sediment itself becomes one of the agencies in removing the deposits of centuries.

An opinion may now be formed of the durability of both jetties from their starting points to within two thousand feet of the sea ends.

Safety of foundation, proper slopes, tightness, and protection from overflow being the points to be examined, it is believed that the following points have been conclusively proven:

1. That the foundation is absolutely safe.

2. That the slopes of the work are protected by natural slopes, formed of the mud, sand, and clay deposited by the river.

3. That tightness has been obtained for the jetty embankments to a degree very nearly equal to that of the natural banks of the pass, the only difference being that the top mattress is not yet filled with the mud, and, therefore, the leakage not completely stopped.

4. That the protection from waste of water by overflow is checked to the datum plane of average flood tide.

Hence, referring back to the plans adopted for consolidating the first eight and nine thousand feet of the jetties, it will at once be seen that the only remaining point on the strength of which the permanency of this part of the jetties might be questioned has been carefully considered.

The compressive strength of the proposed paving, in combination with the gravel and small stone, that is to be filtered into the mattresses, will have the tendency of stopping any superficial or lateral escape of water, with the ultimate result of turning it into its legimate course between the jetties.

Nothing has been said, so far, of the sea ends of the jetties, except the description of the plans designed for their permanency.

The term "sea-ends" applies to the lower parts generally, without clearly defining their limits. It is understood, however, that as soon as the jetties emerge from the shelter of the reefs, the degree of exposure increases and continues to increase until the extreme ends are reached.

By far the most troublesome parts to maintain have always been the lowest six hundred feet of both jetties.

In planning the construction of the lower ends, the expediency and importance of a larger pier section were among the special features of the original designs. But, as has been already remarked, the vital point upon which success depended most was a rapid and economical construction. The money to carry on the works had to come from sources opened by the success which the works themselves would produce, and, under the weight of the circumstances, the area of pier section was increased but slowly in the beginning.

The repairs which from time to time became necessary made it imperative, however, that, at the earliest possible moment, such measures should be taken as would bring up the lower ends of the jetties to the standard of strength required for their permanency. The plans adopted aim at the accomplishment of this purpose.

In the development of this subject it should be stated that in addition to the three destructive forces already mentioned, two new elements were here introduced which became detrimental to the jetties and delayed rapid construction. We refer to the subsidence of the bottom and to the depredations of the worms.

The subsidence of the bottom and the natural compression of the willow work, are items that should be distinctly kept apart. But the analogy in the effects of both made it difficult to ascertain their extent correctly and separately.

However, the depression of the surface of the work has been carefully observed from bench marks, established on some of the best settled old piles. The coefficients of shrinkage thus obtained with reference to the original depth were:

$$\text{At the upper end} = 0{\cdot}33 \times \text{depth.}$$
$$\text{At the sea end} = 3{\cdot}00 \times \text{depth.}$$

Both values include compression of willows and subsidence of the bottom, with the strong probability that the mattresses were equally compressed throughout by yielding their elasticity, while the actual subsidence varied with the consistency of the bottom.

Accepting one-half of the total depression as found at the upper end, as being due to compression, and the other half as being due to subsidence, we have the elements of an equation by which to ascertain the amount of actual subsidence which took place at the sea ends of the jetties, namely:

$$S = 4\,d\left(1 - \frac{0{\cdot}33}{2}\right) - d^*$$

It was not until the fall of 1877 that, after adding tier upon tier of mattress and increasing thereby the weight of the whole structure, the foundation was forced through the quicksands below, and struck a bed on the older, harder, and firmer strata of bar deposit.

Near the extreme end not less than sixteen tiers of mattresses have been sunk, representing a vertical height of twenty-six and three-fourths feet of compressed willow work. The original depth of this place was eight feet, from which we conclude that eighteen and three-fourths feet of the work are below the original bottom of the bar.

It may be added that the rate at which the sinking proceeded was very marked in the beginning, but since the fall of 1877 the tendency has greatly decreased, if it has not stopped entirely.

Engineers will understand the difficulties which surround the observer who tries to follow up a system of levels on a territory likely to sink with his bench marks a fraction of a foot daily. We can do no otherwise than regard the results coming from such sources as approximations.

As to the depredations by the worms, it should be stated that out of twelve months of the year, seldom more than three months have been favorable for the worms to work. During these three months, which embrace the low water stage of the Mississippi, September, October, and November, the surface water is brackish at the mouth and in the pass, and it is salty or nearly so from a depth of five feet down, near the end of the jetties and seaward (hydrometrical reading 1,010 at 60° temperature).

During the construction of the jetties the following facts have been elicited bearing on this question:

1. No trace of worms has ever been found above a point ten thousand feet below the eastern lands' end.

2. Below that point ravages of the worm have been observed, chiefly resulting in honey combing the lower parts of piles and mattress binders, as also attacking the butt ends of willows.

3. No worm eating is found to exist on any material from the surface to a depth of five feet below. From this point it may extend to a distance of about eight inches below the bottom.

By the more liberal application of stone during the past two years, the willow work at the sea ends has generally been kept well covered, and has thus received a protection against the continuance of injury from the worms. Not much damage has come from that source during the low water seasons of 1877 and 1878.

In January of the present year, a board of officers, appointed by the President, visited and examined the works. Touching this subject the following is said in their report:

"The teredo does not attack wood where the free access of sea water is impeded. Those portions of a stick buried in mud or sand, or packed around with mud or sand, are secure. We have no reason to believe that the teredo has penetrated or can penetrate far into the interior of the mattress courses; we have pretty good reason to believe that the foundation mattresses are and will remain secure; and probably also the bulk of the interior of the masses of willow work."

Quite recently an attempt was made to break off at the extreme sea end of the West Jetty some piles which were obstructing the palmetto work. These piles had been in place since March, 1877, and it was thought they could easily be broken off. But the inability of a powerful tug

* *d* stands for original depth of bottom.

FIG. 1.

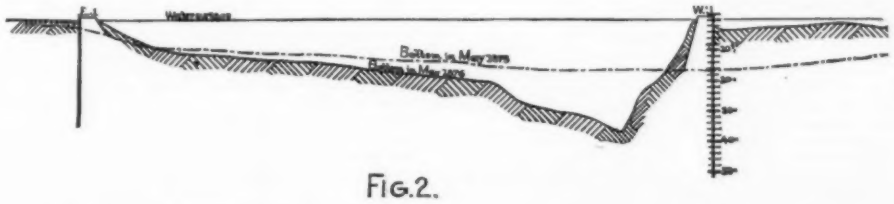
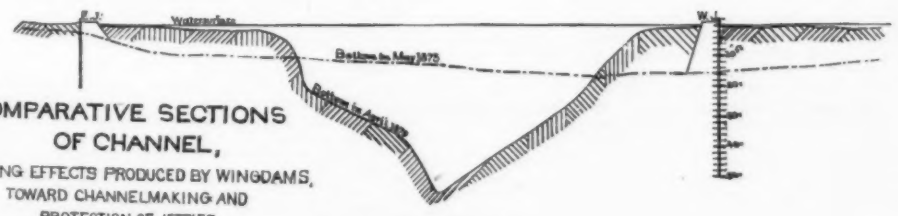


FIG. 2.



COMPARATIVE SECTIONS OF CHANNEL,

SHOWING EFFECTS PRODUCED BY WINGDAMS, TOWARD CHANNELMAKING AND PROTECTION OF JETTIES

PLATE IV.

Horizontal Scale of Feet.

to do so proved that the piles were still sound, and it was concluded to let them remain in place.

During severe storms or gales in the earlier stages of the work the superficial layers of mattresses suffered the greatest damage by being displaced and thrown off, after the top of the jetties was dismantled of the stone that was placed there. The main object, therefore, to be gained from a consolidation of the lower ends of the jetties is to give them sufficient strength to resist such violent action of the waves.

Consolidation means compressive strength expended on solids and voids. It is evident that every tier of brush and every layer of stone in the jetties must have solids and voids.

At the upper end of the work the sand, mud, and clay of the Mississippi has been so firmly embedded in the meshes of the mattresses and between the interstices of the stone, that very little additional compression is needed to make the work tight and permanent. But, as the jetties approach the sea end and come in contact with the clean salt water of the Gulf, experience showed that the sediment which had accumulated between the willows and stones during a high stage, would speedily be removed during the subsequent low stage of the Mississippi. As a result the river sustained a considerable loss of water by leakage and overflow, where the volume was needed most to serve the purposes of channel making.

It has been estimated by careful simultaneous gauging that nearly twenty-five per cent. was abstracted from the volume passing the land's end at East Point before it reached the mouth of the jetties. Of this loss the far greater part escaped through and over those portions of the jetties which extend beyond the sheltering protection of the reefs and shoals. It increased at the same ratio as the degree of exposure toward the sea ends, and it became evident that compression by weight would be the only cure for the evil.

CONCRETE BLOCKS FOR THE SEA ENDS OF THE JETTIES.

While the efficiency of rubble stone for consolidating the upper parts of the jetties could not be questioned, the requirements of weight and strength sufficient to resist the shock of the waves at the sea ends could not be obtained from the largest sized rock which it was practicable to bring from the distant quarries.

General Gilmore, in his work on Limes, Hydraulic Cements, and Mortars, speaks of "huge artificial blocks capable by their inertia of resisting the waves of the Atlantic," used in the protection of the Cherbourg breakwater. These blocks weighed forty-four tons, and seem to be the largest on record. The same author also mentions the use of "immense blocks of concrete" at Marseilles, "for the protection of the outer or seaward slopes of the jetties which inclose the basins and docks of that harbor. The concrete blocks weighed about twenty-two tons each."

The smallest blocks which are being put on the South Pass Jetties weigh about twenty-five tons each, and the largest seventy-two tons each, not including the parapet, which is to be built on top.

In perfecting the plans, the protection of the blocks by slopes has been carefully considered.

Slopes are produced by gravity and friction, both forces acting upon the particles composing the slope.

In order that the particles may be at rest and resist separation, weight should be expended in amounts equal to the force represented by friction. Hence, at places exposed to the waves of the sea, the weight of the material used in the construction of a slope should be equal to the force represented by the waves, and the slope will be safe with the degree of declivity due to the weight of the material.

But if the slope be composed of less heavy particles, it must be flattened, and the oblique surface enlarged so as to increase the area which receives and meets the waves.

The plans for slopes now under progress of construction at the end of the jetties may be said to fulfill part of both of these rules.

From the early beginning the important part of slope construction, so highly essential for the preservation of the works, has received due and careful attention.

Single stones, in considerable quantities, have from time to time been used in protecting the lower parts of the jetties, but during heavy gales the sea has been observed to pick up these stones and carry them seaward by the receding action of the waves.

In this manner the sea was slowly set at work to build up a slope of its own, the surface area of which would be in conformity with the weight of the stones and the friction of the waves upon them. A slope of unquestionable stability might have been obtained in this manner, and by continually adding fresh supplies of stone. But such a process would have been slow and very costly.

The section of work, Plate II., Fig. 3, shows that by the introduction of a sloping crib or cell work constructed of palmetto logs, great weight has been combined with abundant surface inclination.

The object of this mode of construction is to obtain compartments of moderate dimensions by which to hold in place the stone and gravel which is used to sink them.

The palmetto is a species of the palm tree which grows in the tropics. Its wood is highly fibrous, tough, and corky. The fibers are most intricately interwoven with each other, very tenacious and strong, causing rapid wear on the tools of the carpenter. Silicious matter has been found in the bark. The wood is said to be impervious to the attacks of the worm, and weighs about forty pounds to the cubic foot.

(To be continued.)

COMPOUND MARINE ENGINE.

WE illustrate above a system of compounding marine engines, patented by Mr. A. Vile, of Southampton. Fig 1 is a vertical section, and Figs. 2 and 3 are plan sections through the slide valves, which are cylindrical. The engine is of the continuous expansion type, the high-pressure piston acting in a sense as a slide valve to the low-pressure cylinder. The steam valve, C, is an equilibrium valve, being fitted to work between its seat and an accurately planed surface at its back, on the cover of the valve chest, as shown, and it is also a blank valve, that is to say, without any exhaust cavity or passage in it. Its weight and size are thus reduced to less than half of the weight and size of the slide valves commonly in use, and having no exhaust passage it can be linked up to any required degree of expansion without causing compression, as the exhaust takes place when the separate exhaust valves, F, are open. The piston, *a*, is of considerable thickness, being preferably equal to the length of its stroke, and therefore equal to half the length of its cylinder, A, and it acts as a valve for controlling the admission of steam to cylinder, B. The piston, *a*, is preferably of the same weight as the piston *b*, so that the pistons are balanced. The ports and reversing valves, connecting cylinder, A, to cylinder, B, are arranged as follows: From the upper end of cylinder, A, a port, D, leads directly into the adjacent end of the casing of the reversing valve, E, and from the lower end of cylinder, A, another port, D^1, leads similarly into the casing of the other reversing valve, E^1, as shown. d d^2 are ports leading from the upper ends of the two reversing valve casings into the upper end of the cylinder, B, where they meet in a single orifice; and d^3 d^3, Fig. 3, are similar ports connecting the lower ends of the two reversing valve casings with the lower end of cylinder, B.

The valves, E E^1, are cylindrical in cross section, and are fitted steam tight in corresponding cylinders or chambers, E^2, in one with the cylinders, A and B, or otherwise. These chambers, E^2, are rather longer than the valves, E E^1, so as to leave a passage for the steam past the ends of the valves, which, when the engines are working ahead, are in the positions shown at Fig. 2, the valve, E, being at the bottom and valve, E^1, at the top of its chamber.

The working of the engine is as follows: The parts being in the position shown, and the pistons moving in the direction of the arrows, steam is being admitted to the top sides, and exhausted from the bottom sides of both pistons. The steam having at first acted on the top side of the piston, *a*, only, when the latter arrived at the middle of its stroke—the position shown—it uncovered the port, D, and admitted the steam directly through that port over the end of valve, E, and through port, *d*, to the top side of piston, *b*. On or before the closing of port, D^1, by the other side of piston, *a*, the exhaust valves opened at the lower ends of both cylinders. Similarly on the return stroke, when the piston, *a*, has been raised by the steam acting on its lower face to the same position—the piston, *b*, being now at the bottom of its cylinder—thereby uncovering the port, D^1, the steam passes directly under the valve, E^1, through port, d^1, to the lower side of piston, *b*. The steam admitted to cylinder, A, thus acts as motive power in both cylinders in the same direction, there being no exhaust jackets, receivers, or spaces where steam can expand uselessly.

When the valves, E E^1, are reversed as above described, the steam passes from the top side of piston, *a*, through port, D, port, *e*, of valve, E, down through the valve, E, itself, and through port, d^3, to the lower side of piston, *b*, and on the return stroke from the lower side of piston, *a*, through port, D^1, through the port, *e*, of valve, E^1, up through the valve, E^1, itself, and through port, d^3, to the top side of piston, *b*.—*Engineer.*

FIG. 1

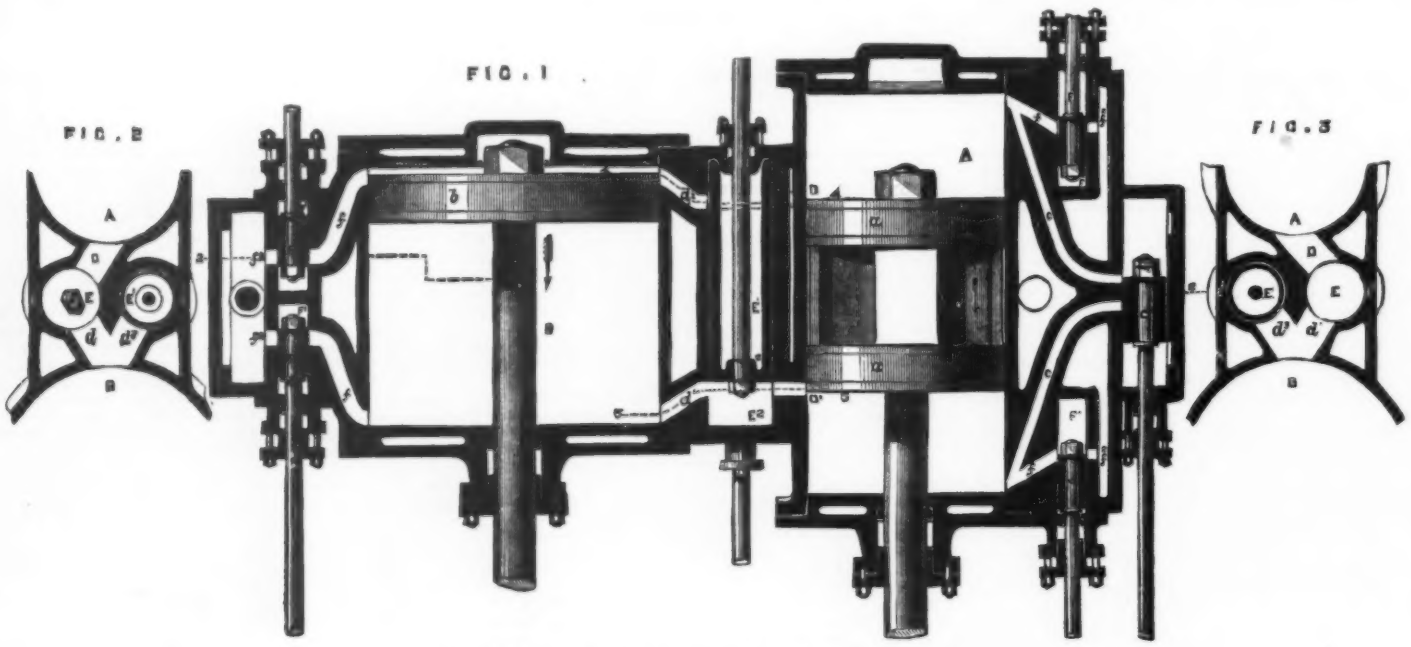


FIG. 2

FIG. 3

VILE'S COMPOUND MARINE ENGINE.

About two years ago, as an experiment, quantities of large rock, weighing from one to two tons apiece, were, at considerable expense, placed upon the lower ends of the jetties. But in a severe gale which occurred a few months later, these rocks were lifted up by the waves, rolled over the jetty embankment, and deposited on the leeward slope, thereby adding, perchance, to the strength of that slope.

In selecting a material which would effectively consolidate the sea ends of the jetties, it was important to bear in mind that gales along the Gulf coast are generally attended by high flood tides, which have been observed to rise from three to four feet above the level of ordinary tides; these call into existence an enormous lifting power that can only be overcome by equipollent means of resistance.

For this reason, and in order to accomplish a permanent consolidation, something more powerful than quarried stone had to be resorted to. The plans of capping the last thirty-eight hundred feet of the East and twenty-eight hundred feet of the West Jetty with blocks made of cement concrete, provide for an application of from twenty-five to seventy-two tons in solid blocks. Their dimensions have been so chosen as to impart great stability, and to dismiss at once all possibility of upsetting.

Cement concrete and lime concrete have been largely used for important marine works at home and abroad. The Prussian harbors in the Baltic, the improvements of the French harbors of Toulon and Marseilles; the gigantic fortifications at Cherbourg, which were raised from a depth of twelve fathoms of water; again, the works of the harbor of refuge at Dover and the Island of Alderney, Great Britain; the foundations of many lighthouses, graving docks, breakwaters and sea dikes, parapets and fortifications, are constructed of blocks formed by one method or the other of cement or lime concrete.

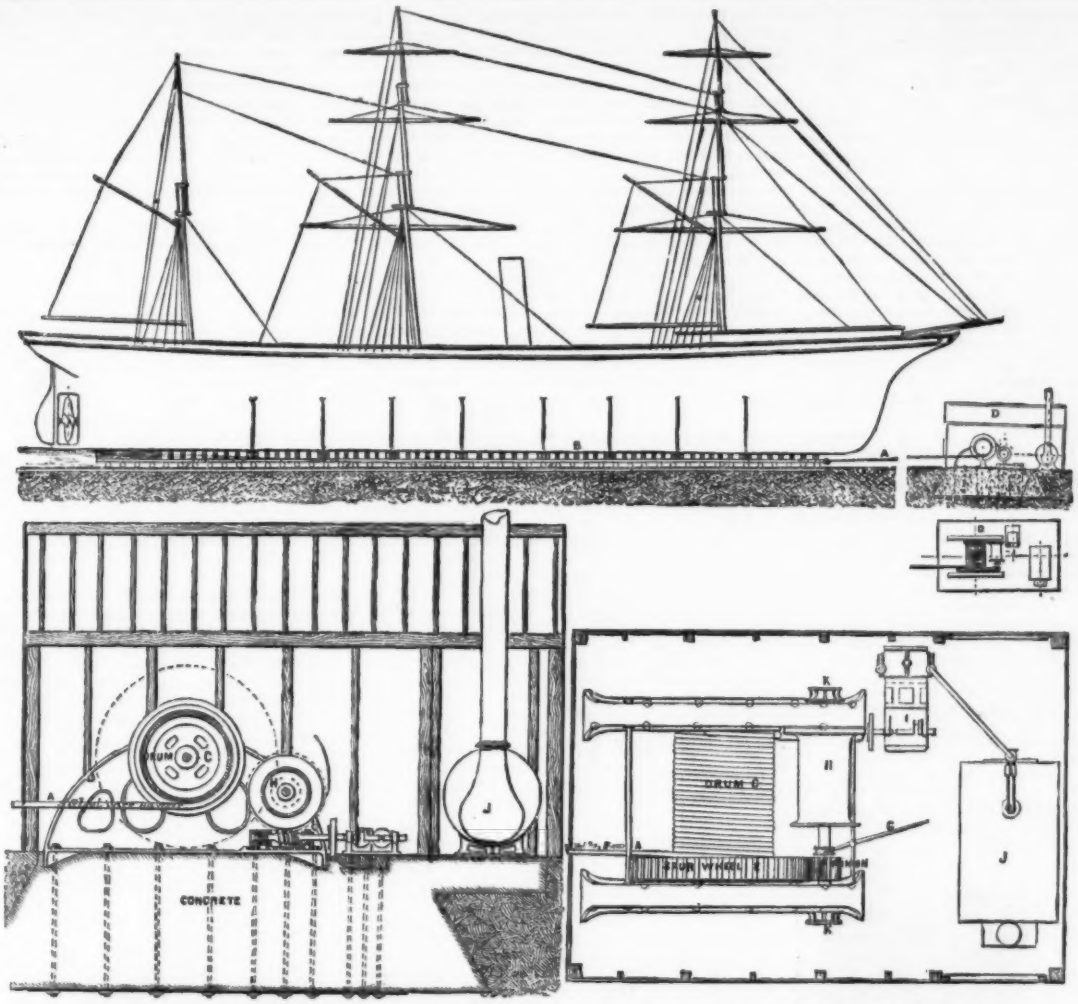
Two more recent engineering works, those at the Sulina mouth of the Danube and those at Port Said, the terminus of the Suez Canal, are being consolidated in a manner resembling the one now under progress of construction at the South Pass Jetties.

I am not aware, however, that in the history of any of these works record is made of blocks weighing seventy-two tons.

NEW MARINE RAILWAY.

THE frequent necessity of examining the bottoms of iron vessels for the purposes of scraping, painting, or repairing, and of steam vessels for obtaining access to the propeller, stern tube, and sea cocks, have tended considerably of late years to increase the demand for heaving-up slips. The Board of Trade has also added to this demand by requiring that every steam passenger vessel shall be surveyed in hull and machinery at intervals of not less than twelve months. We illustrate this week a new arrangement for hauling up vessels, which has been successfully at work for the past six months in the new heaving-up slip of Messrs. Day, Summers & Co., of Northam Iron Works, Southampton, England. In the three views, next page, the same letters refer to the same objects, and B shows a general elevation of the cradle with a vessel on same in the act of being hauled up. A is a flexible steel wire hawser, which is coiled on the drum, C, and this drum is large enough to carry the whole length of the wire hawser without a second coil. To prevent any bruising of the strands of the steel wire against the iron drum, the surface of the latter is covered with hard rope, which is tightly strained on the drum. This protection is found to answer very well, and although fifteen vessels have been hauled up in the six months the slip has been at work, no rubbing or abrasion of the steel wire can be detected.

The spur wheel, E, bolted to the drum, C, is worked by the pinion, F, which can slide in or out of gear with E, and allow the small drum, H, to work independently of the drum, C. The small drum, H, is used for hauling up the empty cradle in a rapid manner, and for unwinding the steel hawser off the large drum. This is effected at low water by throwing the pinion, F, out of gear with E, and by taking round the barrel, H, two or three turns with a light chain, one end of which passes round a pulley at the lower end of the slipway, and is then brought back and made fast to the end of the wire hawser. When, therefore, the drum, H, is set in motion, the light chain pulls the wire hawser off its drum,

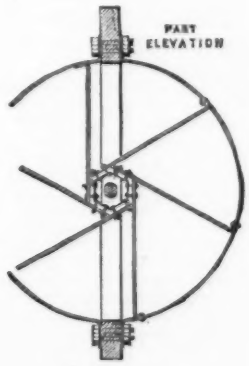


MARINE RAILWAY.—NORTHAM IRON WORKS, SOUTHAMPTON.

and hauls it down to the cradle, where it is made fast to the pennants ready to haul up a vessel when the tide rises. The steam engines, I, have link motion, and work through a worm running in a bath of soap and water, and gearing into a worm wheel bolted to the drum, H. J is an ordinary tubular boiler. K K are small surging barrels for any hauling or lifting that may be required near the slip. The galvanized steel wire hawser employed by Messrs. Day & Summers was manufactured by Messrs. Bullivant. It is 9 inches circumference, 420 feet long, and coils round the rope on its drum, which is 5 feet 2 inches diameter, with the same noiseless pliancy as if it were made of hemp instead of steel. As there is no "fleeting" in this mode of hauling up vessels, the work is done very rapidly, and a large vessel can be hauled up in forty-five minutes after she is blocked on the cradle. Very few workmen are required, for the same reason, viz., the absence of fleeting, and the expense of hauling up is therefore materially decreased. By greasing the steel hawser every time it is used all corrosion is prevented, and Messrs. Day, Summers & Co. expect to make theirs last for many years.—*The Engineer.*

MACKENZIE'S SCREW PROPELLER ASSISTANT.

SEVERAL different forms of rings and tubes have been applied in different positions with relation to the screw propeller of vessels for the purpose of preventing the circular and radial motion of water from the screw; and Mr. Mackenzie, of Central Buildings, Stockton-on-Tees, England, has attached a ring and spokes to the stern frame, just to the rear of the screw propeller of a small vessel, as shown by the accompanying cuts. It is acknowledged that some



power is lost in hauling the ring and spokes through the water, but it is claimed that a considerable gain in speed from the same power is obtained through the prevention of the centrifugal motion of the water. The Assistant has been fitted upon a steam yacht with success, and it is now being fitted to an ocean-going steamer, the Blyth, by Messrs. Smillie & Smith, Tyne Dock, and a considerable improvement in speed is expected. The illustrations show clearly the arrangement and method of fixing the apparatus.—*The Engineer.*

ACOUSTICAL FIRE-DAMP DETECTER.*

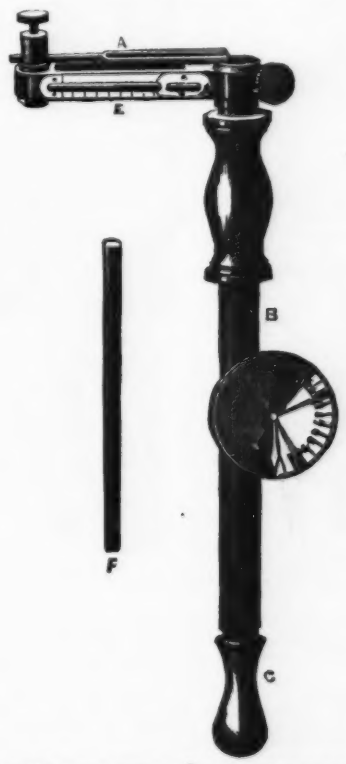
By PROFESSOR GEORGE FORBES.

THIS instrument is intended to measure the quantity of fire-damp in a coal mine. From the rough model shown by Professor George Forbes last year the committee have constructed two new instruments which appear to them to answer their purpose quite well. The one is of a large size, and is worked by an electric battery, and is rather expensive. The other is small, portable, easily worked, and answers all the purposes for which it is required. Both instruments are founded upon the facts that sound travels quicker in light gases than in dense ones, and that air which is contaminated with fire-damp is lighter than pure air The velocity of sound in different qualities of air is compared by noting the lengths which must be given to a brass tube to cause it to resound to a tuning fork. The length of tube is proportioned to the velocity of sound. The instrument consists essentially of a tube, B, with a tuning fork, A, at one end of it, and closed at the other end by a piston which can be moved in and out so as to lengthen or shorten the tube. The tuning fork is caused to sound, and on moving the piston in and out the sound is heard to augment and diminish according to the position of the piston in the tube. The piston must be left in that position which gives the loudest sound. The length of the tube under these conditions measures the velocity of sound, and thence the percentage of fire-damp in the air.

In the large-sized instrument the tuning fork is kept in vibration by an electric current, which is made and broken in each vibration, acting on an electro-magnet so as to maintain the vibrations. The committee have been able to arrange the contacts in such a manner as to prevent the occurrence of a false note of considerable loudness. But in spite of this the ear can detect the true note and regulate the position of the piston with even greater accuracy than when the tuning fork is otherwise set in vibration. The reason is that in other cases there is an irregularity in the loudness of the sound which alters slightly the velocity of the sound.

In the small-sized instrument the tuning fork is set into vibration by means of a striker or rod, F, which is drawn by the hand between the prongs of the tuning fork (which approach each other at their extremities). A little practice enables any one to obtain in all cases the same loudness of sound. The committee have added to this instrument a circular scale, D, along which an index travels, being moved by a rack on the piston, so arranged that it cannot give a false indication. By this means the length of tube can be read off easily even in a bad light.

In its present form the instrument is easy of use and convenient, and cannot easily go out of order. A thermometer,



ELECTRIC FIRE DAMP DETECTER.

E, is attached, by means of which the small temperature correction can be applied. The percentage of fire-damp is read off directly upon the scale.

The accuracy of the instrument is such that the percentage of fire-damp can be determined with an error of considerably less than 1 per cent. The committee would draw attention to experiments described in the *Philosophical Magazine* for April, 1879, which show that a difference of one part in 900

* Paper read before Section A of the British Association at Sheffield.

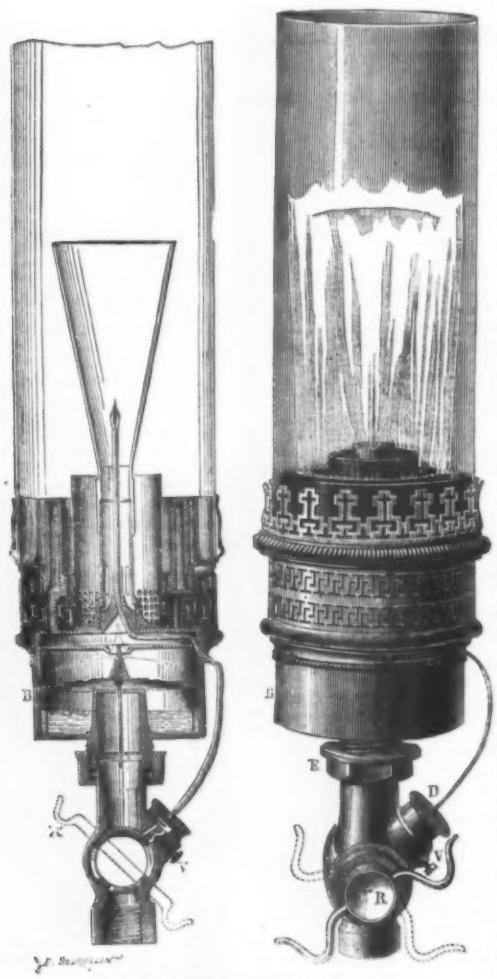
is not found between different observations of the length of tube which resounds to a firm tuning fork.

On August 25, 1879, the committee were enabled to descend the Wharncliffe Silkstone Colliery, by the kindness of the manager Mr. George Walker, who accompanied them with a few other gentlemen interested in the experiments. This pit is at a depth of 200 yards. Mr. Walker had kindly arranged to stop the ventilation of the pit at the end of the workings, so after proceeding a mile through the galleries they came to this spot where they hoped to find a large amount of fire-damp. But only a slight quantity was to be found; the Davy lamp generally showing but a feeble blue cap, and the Forbes indicator registering only small percentages. Disappointed here they were taken by Mr. Walker to another working, where it was thought possible that there might be some gas. Here in a crevice in the roof a flow of gas was found forming a stratum of light gas. Here the instrument indicated quantities gradually increasing from 14 per cent. as the tube got filled with the air in the crevice, up to 28 per cent. But the small quantity of gas rendered this experiment unsatisfactory, and the committee were then taken to a disused part of the mine where it was known that there was a blower. Here sufficient quantities were found, and the instrument registered gas with more readiness than the Davy lamp. But the greatest quantity registered was 6 per cent., or twelve times the smallest quantity which the indicator detects. The fact is that there is in the present form of the instrument a difficulty in filling the tube with the air of the place under examination.

The committee consider that it would be well to alter the instrument so as to obviate the difficulty; and they also recommended that experiments should be made to test whether the calculated percentages of fire damp agree with actual experiment. They have also to report that the instrument was of a convenient form so as to be portable, and was very consistent in its indications, and they can assert that this instrument is capable of detecting and measuring fire-damp even in small quantities.

A NEW RHEOMETRIC GAS BURNER.

WE give herewith, ½ actual size, an illustration of a new 25 foot rheometric gas burner, invented by M. Giroud. This burner gives a light equivalent to that produced by nine Carcel burners of about 2·8 feet each. It is mounted upon a rheometer, which regulates the delivery of the gas and renders it independent of all variations of pressure. The minimum pressure required is 13 millimeters.



NEW RHEOMETRIC GAS BURNER.

The interior space of the burner is taken up by two directors—a cylindrical and a conical one, and which, by directing the current of air upon the flame, render it white and pure.

It is taken apart in the following manner: The two nuts, E and D, are unscrewed, and the cock, R, taken off; and afterward the framework of the burner is unscrewed to give access to the reservoir, B, of the rheometer. This reservoir is then filled with oil of sweet almonds up to within about half an inch of the upper edge of the central tube. The frame is fixed on the reservoir again, and the burner is attached to the cock by fitting the pin which is above the thread of the male screw into the corresponding depression of the coupling, E. After tightening up the nut, E, and the cap, D, the glass cone is placed on the central tube of the burner, and the glass chimney and its cap are put on. In the interior of the glass cone is located a lighting tube, which is extinguished when the burner is lighted, and *vice versa*, by a simple turning of the cock. In the position R, the lighter is extinguished and the burner is lighted; in the position R¹, the burner is extinguished and the lighter is burning as a mere taper. The lighter is supplied with gas through an aperture in the chamber of the cock, and the flame is regulated by means of the screw, V.

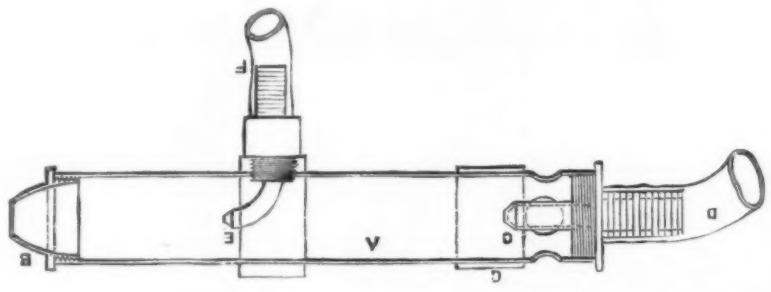
When the cock is being turned to light the burner, the taper (supplied at first only through the hole above mentioned) receives an extra supply of gas through a hole placed above the first; the result being that its flame is thereby lengthened out, issues from the glass cone, and lights the burner. By a further turn of the cock the solid part of the plug is brought opposite the two holes, closing them, extinguishing the lighter, and giving the burner the full supply of gas that it ought to receive. Care must be taken to turn the cock slowly enough to allow the gas to well fill the apparatus, and to give it time to light.

This burner, which is particularly fitted for use in workshops, rooms for study, for drawing, etc. (where it may render aid in ventilation), can also be used for lighting streets, in the ordinary lamps now in use, with a few simple modifications.

AN IMPROVED GAS BLOWPIPE.

By F. H. WENHAM.

IF a mouth blowpipe is made use of, having an orifice in the jet sufficiently large to act upon the entire flame of an ordinary gas-burner a ragged noisy flame will be the result, and we cannot obtain the immovable pointed pencil absolutely required for many operations in fusion and local soldering, and in addition to this objection the large size of the orifice causes such an expenditure of air that a continuous blast cannot be maintained by the inflation of the cheeks, and it is necessary to stop repeatedly in order to refill the lungs. Having frequent occasion to employ the gas blowpipe, I contrived the following arrangement, which I have had in use for a long time. The annexed cut is the full size of the instrument. A is a brass tube having a coned nozzle, B, at its free end. At the other extremity is a screwed plug, having an interior gas nipple, C, and an exterior plug for entering the end of the elastic tube, D, for conveying gas from the nipple socket of an ordinary gas burner; L is a small jet pipe turning into the tube, A, at right angles, so that the orifice (which is very minute) shall direct a stream of air straight in the axis of the body of the instrument; F is an elastic tube, about 18 in. long, provided at the other extremity with a trumpet-shaped mouthpiece of ebony or ivory, with a disk of 1¼ in. in diameter, in order that it may be held securely behind the lips in maintaining the strong pressure required for the blast. The jet at E is much too small to furnish the full supply of air required by the quantity of gas to be consumed—its action is entirely mechanical and inductive by carrying forward the air and gas mixture formed in the tube or body, A. At the base of this there are four orifices or cross openings, as shown. G is a split ferrule; this, when drawn back entirely or partly closes the orifices, in order to proportion the supply of air to the amount of gas let on. When there is a full supply of gas, and these orifices are quite open, with a strong mouth blast the spire of flame issuing from the end at B will be 4 or 5 in. in length, perfectly stationary and quiet, and ending in a fine point. If the heat is too great for the purpose required, and the gas supply has to be turned down, the air regulating ferrule, G, must also be drawn back, else the flame will be extinguished. When properly adjusted, either for maximum or minimum heats, this instrument in either case gives the required pointed flame, and as the orifice of the air jet at E is rather smaller than that generally used in an ordinary mouth blowpipe, a continuous blast can easily be kept up without intermission, with the advantage that the flame can be traversed over the work in any direction instead of the work being brought up, as in the case of an ordinary fixed flame.



Diameter of nozzle orifice at B, 0·23 in.; four openings at base, 0·23 in.; diameter of orifice of gas nipple at C, 0·07 in.; orifice of air or blowpipe jet E, 0·02 in.—*English Mechanic.*

THE THEORY OF ROLLER MILLING.

The Miller, from Gustav Pappenheim's "Popular Treatise on Milling."

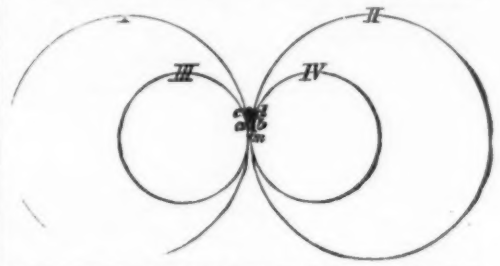
THE efficacy of millstones is not accidental or arbitrary, but is governed by certain rules, which may be determined on mathematical principles, if not with perfect exactitude, at least with a tolerable degree of accuracy.

The same rule holds good with rollers, only in this case the comparative newness of their introduction has prevented similar experiments being made as with the stones, and the few theories which have been advanced by competent judges have been opposed by those of other experts who were quite as competent to express an opinion on the subject.

If we consider, in the first place, the difference between the work of the rollers and of the stones, we find it to consist principally therein, that the rollers accomplish the reduction more by a squeezing or bruising action, while the stones have more of a grinding action. In this respect the rollers possess the great advantage of not tearing or rubbing the husk of the berry, but of squeezing it; and further, the feed is in only a short time between the rollers, which prevents its heating and having any injurious effect on the flour, as is the case with the stones. This is the reason why it is said that "rollers grind cold." The advantages of rollers, in comparison with stones, are, therefore, very important, and it will easily be understood that the rollers, as a matter of fact, are destined to play a great part in the milling trade.

If we follow a grain of wheat, or a portion of it, in its passage through two rotating rollers, we find, first of all, that the berry is seized by the power of adhesion at a certain point, depending partly on the dimensions of the rollers, and partly on the size of the berry. If we regard, for instance, the figure, in which two different pairs of rollers, I. and II. and also III. and IV., are represented, it may be observed that the berry is seized by the large rollers I. and II. at the points, *c*, *d*, while it is not seized by the smaller rollers until it reaches the points, *a*, *b*. The action which the rollers have upon the berry varies according to the nature of the rollers and the construction of the mill. If both rollers are constructed in such a manner as to admit of the one or the other being withdrawn or approached by means of a screw or lever, the movable roller during the operation will neither be able to give way nor to exert an active pressure.

The particles of the feed, therefore, at the first point of contact, will receive no pressure from the side of the mov-



SECTION OF ROLLERS WITH GRAIN PARTICLE SHOWN.

able roller, but only from the drawing-in action of the two revolving rollers, supposing, of course, the necessary adhesion to exist. The squeezing pressure which is thus exerted on the grain is produced in this case entirely by the gear of the rollers, because, through the rotating motion, and by being carried forward by its power of adhesion, the grain is drawn into a gradually decreasing compass, and must there be crushed or squeezed. This reduction takes place regularly if both rollers possess an equal speed. Should the rollers be driven with differential speed, an unequal impelling motion is given to the feed, and a greater friction results, whereby the product acquires another nature. When the speed is equal, the product leaves the rollers in a broad, flattened form, whereby the outer hull or bran remains tolerably uninjured, but still part of the kernel is pressed into the folds. With differential speed, by which a friction takes place, the lamination is naturally not so great, but the hull is cut in a greater degree.

If the arrangement of the rollers is such that they may be approached to one another at will, by means of a lever or springs, and in this manner be made to exert an active pressure, in contradistinction to the passive resistance of the fixed rollers, we find at the first point of contact a pressure on the grain from the side of the movable roller. This squeezing action is, therefore, produced not only by the revolving of the rollers, but in a great measure by the pressure which is exercised by the lever or springs. The first noticeable result here is the diminution in the amount of power consumed, in comparison with the rollers with the fixed pressure. This active pressure tends also to increase the adhesive power of the rolls, and to render an equal speed of the same possible, where perhaps, with a fixed pressure, the feed would enter badly or not at all. Again, with the self-acting pressure a distinction must be made between the arrangement where both rollers revolve at the same speed and where they revolve at unequal speeds.

If the speed is uniform, a commensurate advance of the crushed portions of the berry at both points of contact takes place between the rollers. If the rollers have differential speed, as, for instance, in the figure, where the roller, I., has a greater revolving speed than the roller, II., the point of contact, C, will push forward the particles more quickly than the point, D. A displacement of the inner part of the particles of the berry will, consequently, result, whereby the structure will be loosened. In this case, undoubtedly friction takes place between the several particles of the flour, and the grain is, therefore, attacked in a greater degree by the rollers than when working with uniform speed, but, under all circumstances, less than by differential speed with fixed rollers.

If, on the other had, the construction of the mill is such that only one roller of each pair is driven, and the other, which is pressed by the lever or springs, is carried forward by the friction, supposing this friction to be sufficient to prevent any slipping, the roller which is being carried forward by the friction will attain theoretically the same velocity as the driven one. In actual working this condition will not often be fulfilled, because the feed may not enter regularly, and the material of the roller may not be so even as to exclude all differences. In such a case it would happen that many points of the roller would remain behind, thus creating a kind of differential speed; but such a case should not occur if the rollers are properly constructed and in good working order.

As regards the action of the pressure where only one roller revolves, it is to be observed that this pressure, which is exercised by the lever or by the springs, must serve not only to produce the friction, but also to reduce the grain. If, therefore, the pressure which is requisite for causing the one roller to revolve on the other, is greater than that requisite for reducing the grain or the middlings therefrom, it is evident the grain will be crushed in a higher degree than is desired, and at the same time a larger amount of power will be consumed than would otherwise be necessary.

If, however, the pressure requisite for producing this frictional action is smaller or equal to that necessary for reduc-

ing the grain, the rollers will be carried round, without any detrimental results. The former case would most likely happen when grinding soft middlings, and the latter when grinding hard middlings. At any rate, this view seems to be supported by the fact that in Austria-Hungary, where hard wheats are ground, the frictional roller is employed, while in Germany, where they have soft wheats to grind, it is not held in much favor.

From what has now been said, we may arrive at the following conclusions.

1. Rollers of large diameter draw in the feed better than those of smaller diameter.

2. Rollers with a fixed or unyielding pressure cause greater friction than these with self-acting pressure, consume, therefore, more power, and rub the grain more than the latter.

3. Rollers with differential speed cause a better loosening of the particles than those running at equal speed, but they cause a greater amount of friction, a fact which may be disadvantageous when working branny products, but may also be serviceable when grinding middlings and semolina.

4. In grinding hard wheat and middlings therefrom, where one roller drives the other by friction only, the system is almost identical with that in which both rollers work at a uniform speed; but in grinding soft wheats they may exercise too great a pressure, and consume more power than is necessary.

In making use of these theories in practice, it must be borne in mind that they are based on the supposition that the feed enters along the whole length of the rollers in an even stream, which may be considered as a single grain. Still this cannot always be the case, because the stream of grain is not even, nor can it be looked upon as a single grain. A certain friction takes place among the particles of the middlings which tends to modify these theories, inasmuch as the proportion of pressure on the particles of the feed in the middle varies from the pressure exerted on the particles next the rollers, the latter being more crushed. The entry of the feed should, therefore, not be forced, for in this case either a portion of it, as has been demonstrated in practice, will pass through the rollers unground, or a stronger pressure will have to be employed, which would alter the result desired.

MEASURING DEVICES.*

Speed Gauge. A velocimeter.

English patent, No. 2,692, of 1855, is for a speed indicator for locomotives or railway trains, and consists of a governor driven by a cord from an axle of the engine or car. As the balls rise with increased speed, they actuate a lever and that a piston which elevates a colored liquid in a graduated glass tube.

The height of the liquid is therefore the measure of the speed.

See also English patent, No. 2,141, of 1860, and 581 of 1867.

A different idea is involved in those indicators which have a dial on which are inscribed all the stations, switches, crossings, etc., of a journey, and a pointer, which is driven by a wheel of the car, and indicates to the engineer or conductor the position of the train on the line. See English patents, Nos. 11,619, of 1847, 890 of 1858.

The marine velocimeter is a registering log. See Log. See also English patent, 8,645, of 1840.

English patent, 2,892 of 1856, is to indicate the position of a hoisting cage in a mining shaft.

Osborne's speed-gauge is for the purpose of determining the rate of speed at which shafting or wheels are rotating. It has an index hand or pointer, a graduated dial, a current receiver, and retarding spring with a current generator, whereby the force of the current produced in any fluid acted upon by the generator can be indicated upon the dial, which may be so graduated as to express the number of revolutions which the generator makes per second or minute, whereby the trouble of counting and rating the speed by time is avoided. It is applicable for determining the speed of printing presses, spinning and grinding machinery, paper mills, centrifugal machines, and shafting; for determining the proper cutting speed of lathes and planers. It is also applicable to the determination of the speed of steam and other land carriages, of marine engines, and of the belting of machinery generally.

It may be made to give an indication or alarm, whenever a shaft has acquired a certain rate of speed, by effecting an electrical connection whenever the pointer reaches a certain place in its path.

Speed Indicator. 1. (*Machinery.*) A device for indicating the number of revolutions made by a shaft in a given time.

Speed Recorder. A contrivance for recording the speed of a carriage, railway car, vessel, or the revolutions or pulsations of a machine. The record is made up of the progress in a given time; in the case of vehicles of any kind, it is made up of distance and time. An *odometer* or other *velocimeter* usually has a train of wheels similar to those of a gas meter or arithmometer (which see), the reading being taken of the number of revolutions, for instance, within the space since the last reading was had. Such a machine is, after all, a mere *counter*, and does not fulfill the conditions of a *speed recorder*.

Some of the cab odometers combine the factors of distance and time, so that when the cab is moving a record is made by a train of wheel and pointers of the distance traveled; and when the cab is at rest, while still hired, a time measurer is set in motion, which keeps a record of the period of rest. This does not yet fulfill the conditions of the problem, as it is but a double register, and the result is derived from the sum of the two, they not being contemporaneous in action. Cab odometers are to be found in English patents:

No. 14,176, of 1852.	No. 1,035, of 1863.
No. 2,131, of 1856.	No. 2,082, of 1863.
No. 883, of 1857.	No. 1,217, of 1864.
No. 2,894, of 1857.	No. 2,354, of 1868.

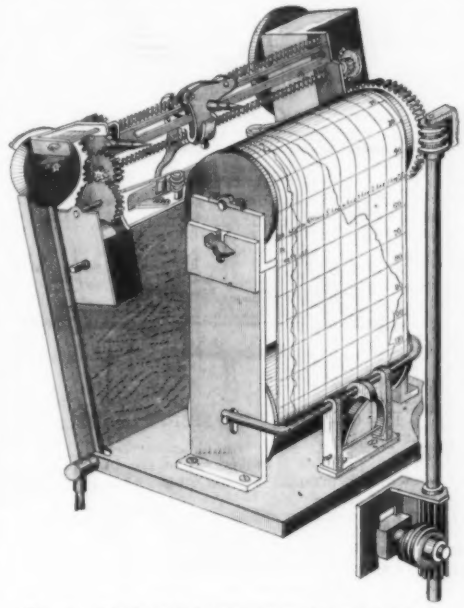


FIG. 2.—RICHARDSON'S SPEED RECORDER.

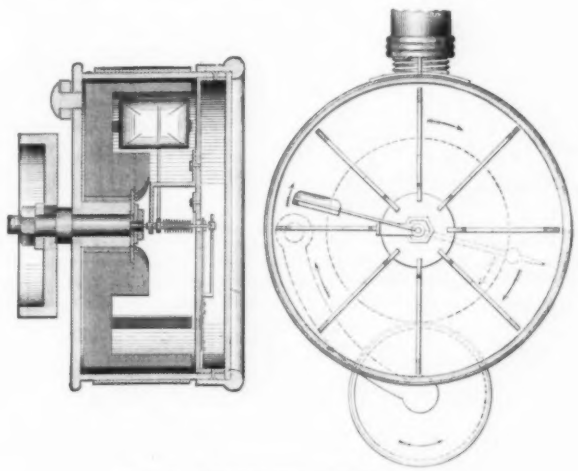


FIG. 1.—OSBORNE'S SPEED GAUGE.

An instrument to be applied or attached to a moving body to indicate to the eye the rate at which it is traveling is a speed gauge (which see). Such a one is not necessarily a *register*, but merely shows the rate at the time of application or of observation, as the case may be. The indications may be recorded, and thus it becomes a *recorder*. One instrument, to indicate the actual speed of a locomotive, is described in English patent, No. 2,692, of 1855. See Speed Gauge.

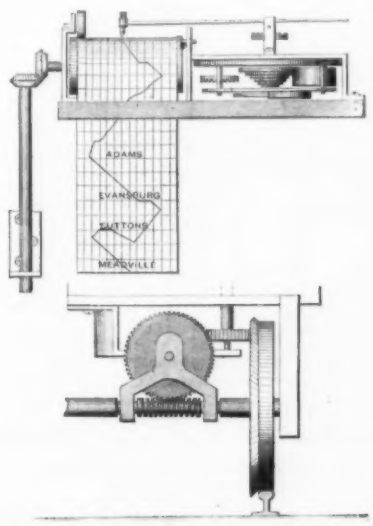


FIG. 3.—WYTHE'S SPEED RECORDER.

The true speed register is to be found in those devices designed accurately to register the speed of locomotives or trains of cars at all times between any two points, to show the time taken to travel any distance between the ends of the route, and to indicate the stoppages and delays of trains.

An apparatus of this kind may be found in English patent, No. 11,619, of 1847. It has dial indicators which show the speed of the engine and the position of the train on the line in reference to proximity to stations or sidings. It registers a description of the journey, time occupied at and the rate between stations, mile by mile. The record is made upon a strip of paper marked with perpendicular lines which represent miles, and with horizontal lines which represent minutes. The paper winds on a cylinder, and is marked by a pencil traversed by a chronometer. The distance traveled in a given time determines the movement of the paper, and the motion of the pencil in the said time combines to make a mark, the result of the two factors. The paper is detached at the end of the journey to be examined, and kept as a record of the trip.

English patent, No. 1,673, of 1857, has also a pencil under the control of a clock, and a traveling paper moved by a wheel of the train, the record being the joint product of time and distance.

English patent, No. 2,141, of 1860, indicates the speed of a train by a colored fluid raised or lowered by a lever acting upon a diaphragm, the lever itself being worked by a ball governor driven by connection to an axle of the engine. A pencil obeys the fluctuations of the fluid and makes a record.

United States patents on the Governor principle. Benckert's, December, 1, 1857. An *indicator*. It has an arrangement of governor balls acting upon segment cams, which turn the pinion of the indicator finger.

Liernur, November 16, 1858. A speed *recorder*. By band connection from the axle, the governor is rotated, and its inequalities of rate are made to lift or depress a pencil vertically. The pencil point rests on a circular disk, which is rotated by clock work. The radiating and circular lines on the paper are expressive of distance and speed, and the pencil line is the product of the two factors.

Billings' speed recorder for railway cars, March 27, 1860. A ball governor, through the medium of a circular rack and gear wheels, imparts motion to a hand, which points out upon a dial the number of miles per hour at which the train is traveling at the moment. Another hand is carried forward by the first hand as the speed is increased, but does not recede with it when the speed diminishes. It thus registers the greatest speed attained during the trip.

Other connected mechanism actuates a set of prickers, which, penetrating at rare intervals an endless strip of paper as it is wound by clockwork machinery from one roll on to another, register the distance traveled; while a second set of prickers, similarly actuated, record the rate of speed at each mile on the same strip of paper. The mechanism is driven from a truck axle, and is inclosed in a box with a glass front.

Keeler, April 4, 1864. An *Indicator*. The balls and connecting arm of an ordinary governor, driven by gear or band connection from the axle, act upon a piston, which raises or lowers the movable bottom of a mercury chamber and elevates or depresses a column of mercury rising from the said chamber.

Bowsher, May 12, 1868. An *Indicator*. It has a governor arrangement, the sliding collar actuated by the balls pulling upon a cord, which turns the spindle of the pointer finger and directs it to figures on a dial.

Bilgram, August 22, 1871. An *Indicator*. It has governor balls, which actuate a sliding sleeve rack, which revolves the pinion on the axis of the pointer.

Speed and Ponge, May 12, 1874. A *recorder* for registering the speed of railway trains. The governor is connected with a pencil, which rides over a recording sheet and indicates the speed, while the sheet is moved by the axle of the car and indicates the distance passed over.

The following are not actuated by governor balls:

English patent, No. 1,407, of 1863, makes a diagram on a sheet of paper, showing the speed of a train, with the position and duration of its stoppages. The paper is advanced by clockwork at a uniform rate, and by means of motion derived from the train a pencil is advanced across its surface. The direction of the line made by the pencil will vary as it moves more or less quickly across the advancing paper.

English patent, No. 2,285, of 1863. A disk of paper is moved by a train of wheels from the crank shaft of the machine. A stylus is raised and lowered at regular intervals, being driven by a chronometer. See also No. 2,912, of 1862.

Lewis' velocimeter, November 26, 1867, has a train of gearing, which gives indications at regular intervals of the rate of speed. These are compared with a time keeper in the same apparatus.

Horn's mileage register, May 5, 1868, has a ringing mechanism operated at each mile; a kind of *odometer*. A striker also marks on a surface traversed at a uniform rate across its path.

Guebhard and Tronchon, April 8, 1873, recording apparatus for cabs and carriages, have a drum driven by clock work and receiving a record so connected with the vehicle as to give a strong and irregular line when the vehicle is moving, and a light and smooth line when it is at rest. By means of a screw movement the pencil is carried in oscillating lines to and fro across the drums.

Richardson's speed recorder, April 29, 1873. An endless revolving chart, driven by the wheels, is ruled with transverse lines to indicate distances, and with longitudinal lines to indicate the time consumed in traveling the said distance. A pencil is actuated by a clock, and made to traverse at a uniform speed across the chart. Thus the endless moving chart, operated by the car wheel, records distance, and the reciprocating clock actuated pencil records time. A third feature. A steam gauge has a pencil attached to record the steam pressure upon the chart, so that its variations are apparent for all the time occupied in the journey.

Wythe's speed recorder for railway trains. July 28, 1874. The chart is ruled with cross lines, for distance and time respectively. It is moved by gear from the car axle. The pencil is moved by clock work. The result, when the car is moving, is a diagonal line, whose angle will depend upon the speed; the pencil always moves in its own proper direction at the same speed, and the paper slips beneath it at a rate corresponding to that of the car.

Brown's revolution *indicator*, September 1, 1874, has a

* From "Knight's Mechanical Dictionary." Houghton & Osgood, Publishers, 21 Astor Place, New York.

mercury reservoir and a communicating pipe, which proceeds radially and then bends upwardly. As the device is revolved by the machinery, the mercury obeys the centrifugal impulse, and passing outwardly and up into the tube descends in the axial graduated tube, its sinking being the measure of the speed of rotation.

Elliott's tachometer, July 28, 1874, is for measuring the speed of vessels. It has a pipe extending through the hull of the vessel, to receive the impulse of the water, and another to be acted on by the suction; cocks are so contrived that either a water or a mercury gauge can be put in connection with the water pipes, for low or high speeds respectively. See also Log; Velocimeter.

Spherometer. An instrument for measuring the curvature of surfaces. It consists of a three-armed frame, standing on three steel pins, which form with each other an equilateral triangle; in the center of the instrument is a vertical screw with a fine thread, and having a large graduated head. The screw is turned downward until its point reaches the surface on which the instrument stands; if this is a true plane, the index of the graduated screw head should mark zero; if, on the contrary, it is either convex or concave, the corresponding positive or negative reading indicates the degree of sphericity.

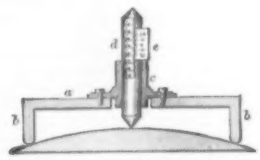


FIG. 4.—SPHEROMETER.

Fig. 4 is an instrument for measuring the curvature of lenses or speculums or of the tools for grinding them. The arm, *a*, has two branches, *b b*, whose ends are accurately turned and ground to a circular form. The socket, *c*, contains a sliding index bar, *d*, with conical ends, which is divided to fiftieths of an inch; a vernier, *e*, enables it to be read to $\frac{1}{1000}$ of an inch, or, by estimation, to $\frac{1}{2500}$.

Spirit-meter. An instrument for measuring the amount of spirits passing through a pipe or from a still. The ordinary *alcoholmeter* is but an adaptation of the hydrometer, having a special scale in combination with a system of tables to be used by the inspector to test the gravity of the wort and mash, so as, in connection with the known capacity of the vessel and correction for temperature, to ascertain the amount of spirits produced.

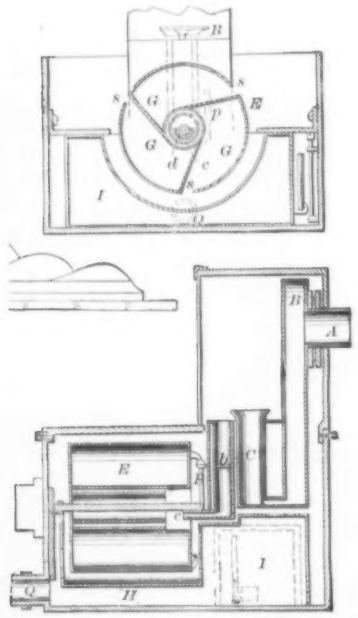


FIG. 5.—AUGENSTEIN'S SPIRIT-METER.

The term spirit meter is more properly applied to a measuring device; and, for internal revenue purposes, the *high* or *low wines* or spirits are occasionally tested by the hydrometer, to find the specific gravity, the quantity of the spirit at proof being deduced from the two factors.

Spirit meters are of several kinds:

1. The rotating drum or tympanum of known capacity, usually divided into chambers, like a gas meter.

2. The piston vibrating in a cylinder of known capacity, and registering its pulsations.

3. Various applications of the device known as the rotary pump.

4. Vessels of known capacity, alternately filled and discharged; usually suspended from a beam whose oscillations as the lighter one rises and the heavier descends are made to actuate an index mechanism. See also Liquid-meter; Water-meter.

(1.) In Augenstein's meter (Fig. 5), the spirit passes from the worm of the still through the pipe, A, into the chamber, B, and fills the upright cylinder, C, whence it overflows into a second upright cylinder containing a straining diaphragm, *b*. It thence flows through the pipe, *c*, and is discharged into the hollow axis of the revolving cylinder, E, whence it escapes into that one of its compartments, G G G, which is at the time in communication with the pipe, *c*. As these become filled, they descend by gravity and discharge their contents through the peripheral openings, *s s s*, into the reservoir, H, whence the liquor is conducted off by a pipe, Q. On the exterior of the cylinder, E, are a series of brushes, or dippers, which take up a small quantity of the spirit from the chamber, H, and convey it to a cup, from whence it is conducted by the pipe, *p*, to a reservoir, I. At suitable intervals the liquor in this reservoir is tested, serving as a sample of all that has passed through the meter.

Each of the compartments, G, measures a given uniform amount, and the flow of spirit into one or the other of them is continuous. Suitable clockwork mechanism is provided for registering the amount which passes through the apparatus.

(2.) Weaver's meter (Fig. 6) has a piston, B, which is caused to oscillate in the cylinder, A, to each end of which the liquid to be measured is alternately admitted through ports, K I, opened and closed by a circular valve, provided

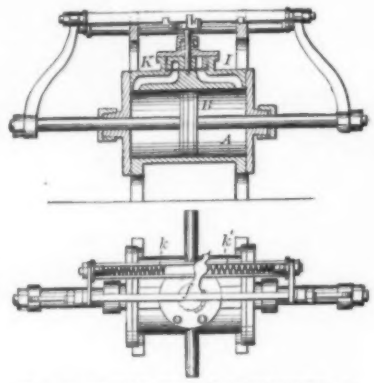


FIG. 6.—WEAVER'S SPIRIT-METER.

with an arm, *f*, which is moved to and fro by springs, *k k'*, one of which is brought into action as the other is released at the end of each stroke.

The valve is circular, and oscillates in a horizontal plane to change the relation of its ports with the inlet and outlet ports. As the piston moves toward the left, the spring in the right hand end of the tube is compressed in consequence of the resistance opposed thereto by the arm projecting from the valve stem, but when the piston has nearly completed its stroke, said arm is freed and actuated by the compressed spring so as to suddenly reverse the valve. The springs being duplicated, the operation is the same under the opposite movement of the piston.

(3.) The rotary pump principle is sufficiently illustrated in Figs. 4,465, 4,466. See also the devices under Rotary Steam-engine, Plate LIII., page 1991.

(4.) Tice's meter is shown in Fig. 7. The spirit coming from the still through the pipe, A, is received in an exterior chamber containing a thermometer, E, and an upright

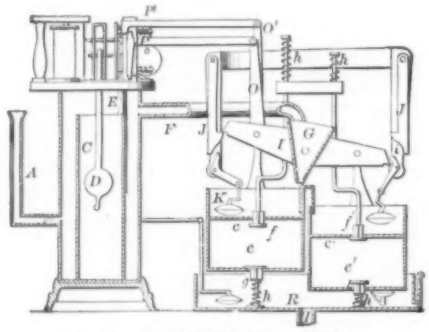


FIG. 7.—TICE'S SPIRIT-METER.

cylinder, C, in which is placed a hydrometer, D. The thermometer and hydrometer may both be self registering, and leave a continuous record on an endless band of paper.

From the chamber the liquid flows through the pipe, F, into the tilting hopper, G, on a rock shaft, I, by which it is directed into the weighing cans, *e e'*, alternately. These are each divided into an upper and a lower compartment, by light diaphragms, *e e'*, having valves, *f f'*, which admit the liquor from the upper into the lower compartment when the can is raised, as at *f*. While in this position the elevated arm of the rock shaft, I, is engaged by one of the swinging

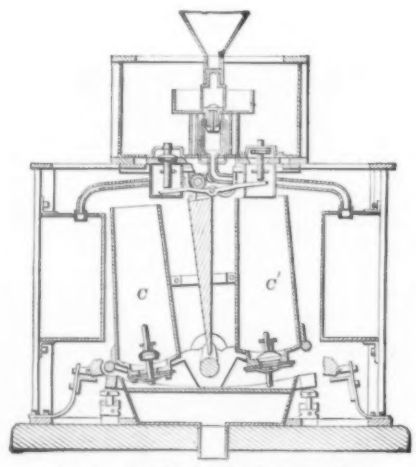


FIG. 8.—PAYNE'S SPIRITOMETER.

latches, J J, which prevents the can from descending until enough liquor has accumulated above the diaphragm, *f*, to raise the float, K, causing a bent pivoted arm, *i*, to which it is connected, to act against the latch, J, and release the shaft, I, permitting the can to descend. The valve, *f*, then closes by the action of the spring, *h*, on its stem, while the valve, *g*, provided with a similar spring, opens, and the liquor flows into the trough, R, and is conducted away by a pipe, *q*. This operation alternately takes place with each can, the number of times each is filled and emptied being automatically recorded by suitable registering mechanism operated through the medium of the levers, O O', P P'. The amount measured each time is that contained in the lower compartment only.

Devices are attached to the meter to indicate if any attempt has been made to tamper with the meter or pass liquor through it without being properly measured in the cans.

In another form of the meter, siphons are employed to discharge the cans, which may be connected to a weigh beam in order that the strength of the spirit may be ascertained directly from its weight.

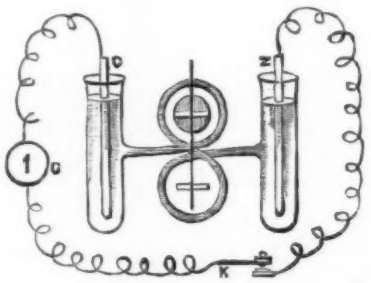
Payne's meter (Fig. 8) consists of a frame containing the tanks, C C', which are placed on a vibrating yoke. The distilled spirit passes first into one of the tanks, and when it has filled the tank, causes it to overbalance the empty one, which is in turn filled, the first one being emptied automatically at the same time by a valve beneath. The tanks are thus filled and emptied alternately; the number of times each is filled and emptied being recorded upon dials by means of suitable mechanism. As the spirit passes through the tunnel into the tank, a small quantity is retained in the sampling device, and caused to flow into the receivers. The sampling device consists of a tube, provided with valves, supported by a suitable mechanism, the valves being so arranged that at each oscillation of the tanks they will allow the sample contained in the tube to pass into the chamber, and from thence into the receiver.

ON A GALVANOMETER FOR DEMONSTRATING THE INTERNAL CURRENT TRANSMITTED THROUGH THE LIQUID WITHIN A VOLTAIC CELL.*

By CONRAD W. COOKE, C.E., M.S.T.E.

IT is, of course, well known that when the external circuit of a voltaic cell is closed a current of electricity is transmitted through that circuit, and at the same time a current of equal strength is transmitted through the liquid within the cell from one plate to the other. These two are in reality but portions of the same current, and are for convenience known as the external or internal currents respectively, to distinguish that portion of the main current which flows through the external conductor from that portion which is transmitted from plate to plate within the cell. The former of these is detected by its electro-magnetic and electro-chemical effects, producing deflections in galvanometers and electroscopes, and sounds in telephonic instruments, and is utilized in all the applications of voltaic electricity.

As far as the author has been able to find out, there has



not hitherto been any satisfactory means in the hands of the demonstrator of physics by which the existence of the internal current within a single cell can be made apparent. Faraday, in the course of his early researches, made the following experiment: he suspended a magnetic needle by a silk thread, and lowered it into the liquid between the plates of one cell of a voltaic battery, so that its length should lie in a plane perpendicular to those of the plates, and he observed that when the needle was just below the surface of the liquid it was deflected the moment that the external current was closed. On lowering it still deeper (the current being maintained complete) its deflection gradually diminished as the depth of immersion was increased, until it reached a position about half the depth of the liquid, when it returned to zero, and after passing this depth it was again deflected, but this time in the opposite direction, its amount of deflection in either case increasing as its distance from the neutral or central point was increased. The cause of this phenomenon is obvious from the following considerations: If a wire carrying an electric current be held *above* and parallel to a magnetic needle, the latter, obeying Ampère's law, will be deflected with an angular displacement dependent upon the strength of the current and its distance from the needle; and if the same wire be held *below* the needle, the latter will be similarly deflected, but in the opposite direction. Now the flow of electricity through the liquid in a voltaic cell may, for the purpose of this explanation, be looked upon as made up of an infinite number of currents transmitted in a horizontal direction from one plate to the other; and when a magnetic needle is immersed just below the surface of the liquid, all these currents are flowing in one direction below it, and a corresponding deflection takes place; when, however, it is lowered deeper into the solution a certain number of currents are flowing below it, tending to deflect it in one direction, and a certain number are flowing above it, tending to deflect it in the opposite direction, and its permanent deflection is due to the electromagnetic effects of the difference between the two. When these become equal, as they are when the needle is at the middle of its depth, their effects on the needle are balanced and neutralized, and no deflection takes place, and when that point is passed, the currents above the needle are in excess of those below it, and a corresponding deflection in an opposite direction is given to the needle. This is an interesting experiment, but is very difficult to repeat, on account of the feeble and unconcentrated nature of the electric currents above and below the needle, and the resistance offered to its motion by the liquid in which it is immersed.

Prof. Hughes, by placing in the current of a battery an apparatus, such as a clock microphone, or a key by which an intermittent or undulatory character may be given to its current, and holding one side of a rectangular coil of wire

* A paper read before Section A of the British Association at Sheffield, 1879.

in circuit with a Bell telephone over one of the cells of his three-cell battery, a secondary intermittent or undulatory current was induced in the coil by that portion of the primary circuit transmitted through the cell, and a corresponding ticking was heard in the telephone.

In both these experiments, however, the effects observed must be attributed rather to the external current of the other cells than to the internal current of the cell under experiment; and the author is unaware that any successful attempt has hitherto been made to construct an instrument which shall utilize *the whole* of the internal current of a single voltaic cell for the production of electro-magnetic effects. While engaged in some experiments a few years ago, it occurred to the author that if a voltaic cell were divided into two portions, having the zinc element in one portion and the positive element in the other, and the solution contained in the one portion were connected to that in the other by a tube filled with the same liquid, the tube being coiled round a magnetic needle, a deflection of the latter, due to the current within the cell being forced by the convolutions of the tube to circulate around the needle, would be produced when the two elements were connected together, and an apparatus was constructed, which consisted of two glass tubes closed at their lower ends with perforated corks, through which the ends of the coiled tubes are inserted. Within the rectangular coil of the tube was suspended a magnetic needle, and the whole having been filled with diluted sulphuric acid, a plate of zinc was placed in one tube and a stick of carbon in the other. On making connection between them by means of a wire, a slight deflection took place, but owing to the feebleness of the current, the directive action of the earth's magnetism and the friction of the pivot, the instrument was not sensitive enough to be satisfactory, and the author therefore designed the instrument shown in the diagram, and which is exhibited on the table, which consists of two glass test-tubes united together by a small tube about 2 ft. long, and convoluted into two circular coils after the manner of a Thomson's reflecting galvanometer. Within the coils is suspended an astatic system of magnetic needles of which the upper carries a light mirror by which its deflections may be made apparent by the movement of a spot of light on a screen. It may, therefore, in this respect be looked upon as a Thomson's reflecting galvanometer, coiled with liquid instead of with metallic wires. The elements are placed one in each of the little cells, and may be connected by a key; or, by placing a reflecting galvanometer in the external circuit, both currents may be simultaneously indicated on the screen and their interdependence or identity be demonstrated. The first instrument constructed by the author was made by connecting the two cells by means of a tube of India rubber coiled round two cardboard cylinders, but through the kindness and unrivaled skill of his friend Mr. Gimingham, whose name is now inseparably connected with the splendid researches of Mr. Crookes, he was able to produce the instrument on the table, in which the tubes and coils are of glass all in one piece, and it is a very beautiful specimen of accuracy of glass blowing. Below the base of the instrument is a fine slightly magnetized sewing needle, which can be rotated on a vertical axis through a small angle by means of a little lever, and by which the instrument can be adjusted to zero.

The author has been induced to bring the instrument before Section A of the British Association, in the hope that it may be useful, not only for science teaching, but for aiding investigations connected with the physical action of the voltaic battery.

GAIFFE'S NEW BATTERY.

THE report by M. le Comte du Moncel on M. Gaiffe's peroxide of manganese and zinc chloride battery states that the advantages of the Leclanché battery (manganic peroxide and sal ammoniac) are well known, as it will act for entire years without attention. Hence it is almost universally applied for electric purposes where no great power is needed. If the manganic peroxide, however, is once exhausted they are rendered unserviceable, and must be replaced by new ones. M. Gaiffe, by his new arrangements, has overcome this difficulty, so that the elements may be charged as easily as in other batteries. He places the peroxide of manganese in several deep holes excavated in the cylinder of carbon, which forms the negative electrode and which serves at the same time as a porous vessel. This carbon is steeped in a solution of zinc chloride, which serves as the exciting liquid, and a rod of amalgamated zinc forms the negative pole. The chloride of zinc should contain from fifteen to twenty of the salt of zinc, as neutral as possible and free from lead. The manganese should be in granules. The electromotive force of this element is equal to a couple and a half of Daniell.

THE CURRENTS OF AMPERE, AND ON RESIDUAL MAGNETISM.

By M. TRÉVE.

A SHOCK upon an electro-magnet, whether solid or tubular, at the moment when the current ceases, is sufficient to diminish the duration of its demagnetization to a considerable extent, and is consequently a remedy for remanent magnetism.

ON THE PRESENCE OF NITROGEN IN STEEL.*

By ALFRED H ALLEN, F.I.C., F.C.S.

THE author made some preliminary experiments on this subject in 1872, but has only recently obtained any definite results. The method adopted has been to dissolve the steel in hydrochloric acid, by which means any combined nitrogen may be presumed to be converted into ammonia. The solution obtained was then distilled, with excess of lime, and the distillate examined for ammonia by Nessler's method. The employment of this extremely delicate test enabled the author to operate on a much smaller quantity of steel than was employed by previous investigators. Very special precautions were taken to obtain the hydrochloric acid and other materials free from any trace of ammonia or nitrous compounds, and the air was entirely expelled from the apparatus before commencing the operation. The hydrogen evolved was free from any traces of ammonia, by passing it through a tube filled with glass beads, moistened with hydrochloric acid. It was proved by blank experiments that no source of ammonia existed in the reagents or apparatus.

When absolutely pure materials were used, and every precaution taken to get rid of the contained air and other sources of error, the addition of Nessler's solution to the liquid obtained on distilling with lime, caused a very marked yellowish brown coloration. On comparing the tint produced with that yielded by a dilute solution of ammonium chloride of known strength, results were arrived at representing the proportions of nitrogen present in various typical specimens of steel.

As the results obtained from steels of different kinds varied greatly, it cannot be assumed that there was a constant source of error in the mode of manipulation; while, as the same samples gave substantially concordant results on repeating the experiment, the figures obtained are not the result of accident, but are true expressions of the proportions of nitrogen present.

In order to obtain ammonia in quantity sufficient for its recognition by other reactions than that with Nessler's test, the following plan was employed:

Steam, generated by boiling water in a flask, was passed over a considerable quantity of steel borings, contained in a combustion tube, which was bent beyond the furnace, and prolonged so as to form the inner tube of a Liebig's condenser. To the further end, a tube filled with glass beads and furnished with a glass stop-cock was attached. A rapid current of steam was driven through the apparatus for a considerable time, to expel every trace of air. On condensing the steam, it was found free from any trace of ammonia. The steel borings were then heated to redness by a combustion furnace, and a rapid current of water passed through the condenser. The condensed steam, when tested by Nessler's solution, was found to contain abundance of ammonia, which did not diminish in amount till the borings were almost entirely oxidized. On re-distilling the condensed steam, a distillate was obtained, having a distinctly alkaline reaction to litmus paper, and on treating it with hydrochloric acid and platinic chloride, a sensible amount of yellow precipitate was obtained, having the characteristic crystalline form of ammonium chloroplatinate. The amount found was larger than could possibly have been produced had the whole of the nitrogen of any residual trace of air been converted into ammonia.

The author regards the results now recorded as preliminary merely, and proposes to extend the research to various classes of steel and iron, and especially to such specimens as have been found to possess anomalous characters. Of these characters, the evolution of ammonia from freshly fractured surfaces is among the most striking.

* Abstract of a paper read before the British Association for the Advancement of Science, (Section B,) Sheffield, 1879.

THE FINEST DIAMONDS IN THE WORLD

WESTERN sovereigns are not the possessors of the finest diamonds in the world, for the Rajahs of Matan, Borneo, and the Shah of Persia have the largest hitherto known. The one belonging to the Emperor of the Monguls weighed 279 carats (about four grains each), and was valued at 12,000,000 francs. The famous Orloff, the property of the Russian crown, is one of the most remarkable diamonds, on account of the well known circumstances under which it was brought to Europe. The large stone belonging to the Emperor of Brazil, which weighs 1,730 carats, would be worth many millions were not its brilliancy diminished by certain defects. The Sultan of Nizam's diamond weighs 400 carats; that of the Emperor of Austria 29 grains; and that of the King of Portugal, 25½ grains. The famous Koh-i-Noor, or Mountain of Light, is the property of the Queen of England. The one which adorned the tiara of Pius IX., and was bequeathed by him to his successor, Leo XIII., is one of the finest stones known. It came from the treasury of the Duke of Burgundy, seized at Granson. It was sold after the battle to a Jew of Berne for 3 crowns, then successively for 5,000 and 6,000 ducats, and afterward purchased for 14,000 by Luigi Sforza, from whom it passed into the hands of Pope Julius II. for 20,000 ducats. Every one knows that the "Regent," of the weight of 136 carats, is the finest of the diamonds belonging to the French regalia. Connoisseurs consider it to be worth 12,000,000 francs—*Galignani.*

ON THE DISSOCIATION OF CHLORINE.

By F. P. DUNNINGTON, University of Virginia.

IN view of the following facts, the question suggests itself whether due care has been taken to exclude the possibility of oxygen compounds being present in the experiments, from which the decomposition of chlorine was inferred, in the article published in the *Chemical News*, vol. xl., p. 69.

During the past year, in undertaking to making liquid Cl from $PtCl_4$ made by HNO_3 and HCl (the latter in excess), I experienced some difficulty in obtaining it free of nitro compounds.

After heating about 30 grammes $PtCl_4$ until Cl was given off, thrice it was treated with water, causing the evolution of nitrous fumes, and heated again until Cl was given off. This material, sealed in a glass tube, on being further heated gave Cl, which condensed at first to a clear yellow liquid (exactly similar in color to that of liquid Cl made from $Cl5H_2O$), but on continuing the heat the condensed liquid assumed a red-brown tint. From the fact of the nitrous fumes having been evolved when it was last treated with water, I presume the reddish tint of this liquid due to NOCl or $NOCl_3$. On opening the tube, when most of the Cl had escaped, there remained an odor very similar to that of ClO_2.

In a previous experiment, when the $PtCl_4$ was but once moistened after drying, the condensed liquid Cl had from the first this same tint, though to a more marked degree. In another experiment I did obtain the Cl from $PtCl_4$ wholly of the clear yellow color.

In these experiments the residue after heating consisted of $PtCl_2$, with but little Pt and $PtCl_4$.—*Chemical News.*

DETECTION OF PHENOL.

DR. E. HOFFMANN pours into a small test glass 1 or 2 c.c. of pure concentrated sulphuric acid, pours carefully over it, so as to form a separate layer, the same volume of the dilute aqueous liquid suspected, and drops in a few granules of potassium nitrate. If only 1 milligramme of phenol be present each particle produces at once violet streaks.—*Chemiker Zeitung.*

DENSITY OF CHLORINE AT HIGH TEMPERATURES.

By A. LIEBEN.

THE author comments on the fact observed by V. and C. Meyer that at temperatures exceeding 600° the sp. gr. of chlorine is only 1·63 instead 2·45 (air = 1). He seeks to explain this fact by the supposition that above 700° chlorine follows a law of expansion different from other gases, its coefficient of expansion being possibly somewhat higher than those of oxygen, nitrogen, gaseous sulphur, etc. He suggests as another explanation that at high temperatures the molecules of chlorine, Cl_2, are dissociated into isolated atoms.

SAPONINE FROM THE BARK OF QUILLAIA SAPONARIA.*

By H. COLLIER, Teacher of Pharmacy at Guy's Hospital.

ONE of the subjects on the list of the Pharmaceutical Conference for investigation is quillaia bark, its chemical composition, properties, and uses. This bark had been under my notice for some time before the issue of this list, but as my chief aim has been to determine more precisely the nature of the saponaceous principle which it contains, I have adopted the above title for my paper. I have been assisted in my endeavors by my friend, Mr. Scard, F.C.S., chemical assistant to Dr. Pavy, F.R.S., Guy's Hospital, to whose practical chemical knowledge I am indebted for the various analyses of saponine which I am able to lay before you. I have by no means exhausted the subject; in fact, what I have to say must not be regarded as a complete investigation of saponine. I have obtained some results which may be looked upon as so many steps of progress toward the goal, but nevertheless there remain many points which are still obscure.

A principle which makes a froth with water similar to that formed by ordinary soap, is very widely diffused throughout the vegetable kingdom. Although generally known as saponine, from its original source, *Saponaria officinalis*, it has other names according to the plant from which it is obtained. All these saponaceous principles may be one and the same substance, modified, perhaps, by the impurities belonging to its extraction. Saponine has been the object of numerous investigations, but most discordant results have been published respecting it by different experimenters. Thus Bussy, Henry, Plisson, and Overbeck state it to be a white non-crystalline friable powder; Rochleder and Schwartz that it is colorless, and Quevenne that it is yellowish white. Again, according to Henry and Plisson it is inodorous, whilst Quevenne asserts that it has a peculiar aromatic odor, and Sharling that the aqueous solution has a repulsive odor. There is also a great difference in the formulas assigned to saponine. According to Rochleder and Schwartz it is $C_{24}H_{16}O_{14}$, Overbeck $C_{42}H_{76}O_{30}$, and Bolley $C_{32}H_{28}O_{31}$.

Before proceeding any further with the consideration of saponine, I think it will be well to say a few words respecting the source, character, and microscopic appearance of quillaia bark. The following description is from the "Treasury of Botany," part ii., 952: "Quillaia saponaria, quillaia or cullay of the Chilians, is a tree from 50 to 60 feet high, with smooth, shining, short stalked, oval leaves, and usually terminal white flowers. Its bark, called quillaia or soap bark, is rough or dark colored externally, but consisting of numerous regular whitish or yellowish layers, and contains a large quantity of carbonate of lime and other mineral matters. It is rich in saponine, a vegetable soap principle, and on this account it is commonly used as a substitute for washing clothes, two ounces of the bark being sufficient to wash a dress. It is also said to remove all spots or stains, and to impart a remarkable luster to wool, and it is used to wash the hair, for which purpose it is powdered between stones, then rubbed with the hands in water, making a foam like soap."

The cortex quillaiæ which I have examined consisted of heavy flat or slightly curved pieces, varying in size from 1 to 4 feet in length, 4 to 8 inches in breadth, and from ¼ to ½ an inch in thickness. The outer bark had been removed; there were, however, a few scattered pieces still remaining. Le Bœuf, who described the color of the tincture he obtained as "d'une couleur orangée foncée," no doubt employed the bark without removing the remaining outside portions. Now this is an important matter, as this outer bark contains a coloring principle which contaminates the saponine. In all my experiments I have operated upon a bark from which every portion of outside layer had been removed by planing and the use of the chisel. The tincture from this is of a pale yellow color. It is not difficult to reduce the bark to coarse powder, if it is thoroughly dry, but if exposed to the air it absorbs moisture, and although it may easily be separated into layers, it is not friable. It is rather an unpleasant substance to powder, the fine dust which arises causing a great amount of coughing and sneezing. Examined by the microscope an opaque longitudinal section of the bark, with one inch object glass and oblique light, gives a general view of the woody tissue, upon and among which lie large crystals of what are undoubtedly oxalate of calcium, as they are unaffected by acetic acid, but are dissolved without any effervescence by hydrochloric. A longitudinal transparent section, part of which is stained with aniline, shows principally the woody fiber with crystals lying about. In the colored section some cellular tissue may be observed, and a few resinoid looking bodies of a brown color. I have one section here which is made in a part where the resinoid bodies are chiefly deposited. These are somewhat of an oval form, and I have every reason to believe they consist of saponine with impurities, giving them a brown color. The bark ignites very readily, and during combustion gives off an aromatic odor somewhat resembling cedar wood. It yields 11·8 per cent. of ash, which consists chiefly of calcium carbonate; there is also a trace of iron.

Henry and Boutron-Charland were, I believe, the first who investigated quillaia bark and separated its saponaceous matter, which they described as an acrid principle. The method they adopted was to boil the aqueous extract with water, filter at the boiling heat, and the saponine which fell down on cooling and concentration was purified by solution in alcohol with aid of animal charcoal. I have prepared saponine by this method, but I was unable to obtain it pure; it would persistently remain brown after all treatment.

The best process is that of Le Bœuf, which consists in boiling the bark with 84 per cent. alcohol, filtering at the boiling point, and upon cooling the saponine deposits. It is purified by washing with alcohol and ether. The principle of the above process is that saponine is more soluble in boiling rectified spirit than in cold, so that the excess deposits upon cooling, leaving above a saturated solution of saponine with coloring and other matters. This tincture upon evaporation yields 2·24 per cent. of solid residue.

The first saponine I obtained by this process, after thorough washing with alcohol and ether, and drying over a water-bath, was a white friable amorphous mass. There were some portions, however, which were not white, but of a decided brown color, and there appeared an oily stain upon

* British Pharmaceutical Conference.—*Pharmaceutical Journal.*

the filter paper round the edge of the saponine. I found it to be very soluble in water, but ether, chloroform, benzol, carbon bisulphide appeared to have no effect in dissolving it. A portion heated on platinum foil burnt very easily, and a white ash remained. This was insoluble in water, but dissolved at once with considerable effervescence in hydrochloric acid. A platinum wire dipped into this solution and held in the flame of a Bunsen burner produced a very well marked red color. The acid solution neutralized with liq. ammoniæ gave on the addition of ammonium oxalate a white precipitate insoluble in acetic but dissolved by hydrochloric acid. An examination for other bodies gave negative results, so that the ash of saponine is composed entirely of calcium carbonate. Now Bolley's saponine contained one per cent. of ash, and one sample examined by Rochleder and Schwartz contained 4·3 per cent. These investigators are, I believe, the only persons who mention anything about an ash.

This discovery of the fact that my saponine contained an ash was the result of a preliminary examination before submitting it to analysis; it was therefore necessary to obtain the amount before proceeding. The plan adopted was to ignite the saponine in a platinum dish; when the carbonaceous residue had become quite white it was cooled and moistened with solution of ammonium carbonate, evaporated to dryness and again heated gently to expel excess of ammonia. The ash was thus weighed as carbonate; 0·49 of saponine yielded 0·0195 of ash carbonated as described, which gave 3·979 per cent. I could not regard this saponine as a pure substance. It had been most carefully prepared according to the process given by Le Bœuf, but the oily stain on the filter paper upon which the saponine had been dried, and the brownish tinge of some of it, were so many indications of impurities. It was necessary for me, therefore, to endeavor to ascertain what was the nature of the impurities associated with saponine, and, if possible, to obtain a pure specimen in order to determine the formula of it.

I have worked upon three different lots of bark obtained at various periods, and the saponine prepared from all of them upon ignition left an ash consisting of calcium carbonate.

Saponine from 1st bark,	3·979	per cent.	of ash.	
"	2d "	3·904	"	"
"	3d "	3·843	"	"

The saponine prepared by boiling watery extract of bark with rectified spirit, and deposition on cooling, contained 4·37 per cent. of ash.

It is a question in what state the calcium exists in saponine. From its mode of extraction and after-treatment it is hardly possible to suppose that the calcium oxalate existing in the bark had been dissolved out with the saponine, and then appeared in the ash as carbonate. The fact that the saponine from different specimens of bark should yield such nearly equal amounts of ash, is very strong evidence that saponine from quillaia bark is a calcium salt. I have endeavored to obtain saponine free from calcium, but up to the present time I have failed to do so.

It is stated by Rochleder and V. Payr that baryta water, added to a strong watery solution of saponine, precipitates saponine-baryta, and that the white precipitate, washed with baryta water, dissolved in water, and then CO_2 passed through the solution, gives carbonate of baryta which separates out, and after its removal the saponine may be precipitated by ether-alcohol. My saponine threw down a brown gelatinous precipitate with the baryta, which did not appear to dissolve in water, and CO_2 produced no effect in the filtrate from the digestion of the barium precipitate.

I next tried precipitating a watery solution of saponine with neutral acetate of lead. The precipitate, which was a very gelatinous one, after washing, was dissolved in water, and a current of sulphureted hydrogen passed through the solution for several hours. No precipitate was produced, but simply a black colored liquid, which, upon dilution with water, formed a clear dark brown solution. Afterward to a similar solution of saponine in water I added oxalic acid until the liquid was distinctly acid. It was then laid aside for several days, by which time the bottom of the beaker was covered with a white precipitate of calcium oxalate. The clear supernatant liquid was decanted, and then neutralized with barium carbonate. It was impossible to filter quite bright, and so it was allowed to remain for a week. At the end of that time the clear upper liquid, which I hoped was nothing but saponine in solution, was drawn off and carefully evaporated to dryness. The result was a brown amorphous mass, which, upon ignition, left some amount of ash in which barium was present.

I next turned my attention to an examination of the tincture from which the saponine had been deposited upon cooling. I considered that, as this tincture was only a solution of impure saponine, a knowledge of its composition might suggest the purification of the saponine. The tincture, evaporated over a water-bath, left a soft, reddish brown, sticky extract. This was digested with washed ether for some days. By this treatment it lost much of its color, but still retained its tenacious character. The ethereal solution was of a yellow color, and when mixed with water became opaque, and after a short time a fatty matter appeared adhering to the sides of the tube. If hydrochloric acid instead of water were employed, the fatty substance at once separated in the form of distinct lumps floating on the surface of the liquid.

These were not dissolved on the addition of alcohol, and no change of color was produced by the application of heat to the alcoholic mixture. Upon evaporating the ethereal solution a soft oily substance remained, which imparted a permanent greasy stain to white paper. It was insoluble in water and alcohol, but readily dissolved by benzol. It was unaffected by alkalies or diluted acids. A similar oily matter may be obtained by adding tincture quillaia to water acidulated with hydrochloric acid. After standing for some time, a yellowish precipitate separates, which, collected upon a filter and well washed with water, dissolves entirely in ether, and this solution upon evaporation gives this oily residue. If washed ether be added to the tincture, this oily principle is also precipitated together with saponine. In this case the precipitate, after being well washed with rectified spirit, and then dried over a water-bath, is resolved into an oily fluid which soaks through the filter. The extract, after being treated with ether as above, was then digested with absolute alcohol for a week. At the end of this time the alcohol had acquired a reddish brown tint, and the extract had become a gray amorphous powder entirely devoid of stickiness. The alcoholic solution, acidified with hydrochloric acid and then heated, became of a cherry red color, which was changed to a dark olive green by alkalies, and restored again upon the addition of acid. The residual extract, treated with water, dissolved entirely, and appeared to be only impure saponine.

I had thus acquired two facts, that the impurities present in precipitated saponine were an oily matter soluble in ether, and a coloring principle soluble in alcohol. It would be necessary, therefore, only to treat with alcohol and ether to obtain pure saponine. But this had been the method of purification always adopted, and I have never obtained saponine without a marked oily stain upon the filter paper, and more or less brown color. I tried digestion with alcohol and ether for several days, but the product was still impure.

At last, after numerous experiments, I found that by boiling the saponine in rectified spirit, filtering at a boiling heat, allowing the precipitate to settle by cooling, and digesting this in absolute alcohol and ether, a very much whiter product was the result. It still, however, gave a red color when heated with rectified spirit and hydrochloric acid. The saponine of which the analysis is given was purified as above, but the solution, deposition, and digestion were repeated a second time. It was a white amorphous substance, and the filter upon which it had been dried presented no appearance of any oily stain, and dissolved in rectified spirit, and acidified with hydrochloric acid. Upon heating no red color was produced. I thus believed it to be a perfectly pure specimen of quillaia bark saponine. It contained 4·13 per cent. of ash, which is higher than that yielded by the other saponines prepared in a similar manner, but not subjected to so thorough a process of purification. Now the saponine obtained from the watery extract gave 4·37 per cent. of ash, which corresponds more closely to the amount obtained from purified saponine. I can say in explanation of this that the last sample being free from oily matter, would yield a higher percentage of ash, and that the product from the watery extract probably contained no oil, as this is not soluble in water, so that its ash approaches more closely that of pure saponine.

The absence of this oily impurity made a perceptible difference in the amount of carbon contained in the last sample of saponine, compared with the first in which it was present. Now this has an important bearing, for the amount of carbon contained in the first saponine I prepared and submitted to analysis was 49·31 per cent., and this corresponds closely to the amount given in the published analyses. Thus:

Rochleder and Schwartz	52·17 per cent.
Overbeck	47·54 "
Bolley	49·54 "
Rochleder and V. Payr	52·97 "
Bussy	50·00 "

It is, therefore, very probable that these saponines containing such a high amount of carbon were not pure, and that the different results are owing to various degrees of purity of the sample examined.

The following is the result of the analysis of purified saponine:

	Calculated from formula $(C_{7}H_{12}O_{7})_{12}CaO$.	Found.
C	43·63	43·51
H	8·88	8·88
O	45·23	45·30
CaO	2·26	2·31
	100·00	100·00

Deducting the CaO, the percentage composition runs as follows:

C	44·53
H	9·09
O	46·38
	100·00

Corresponding to the formula $C_{7}H_{12}O_{7}$, which requires:

C	44·62
H	9·09
O	46·29
	100·00

Considering the large number of atoms in combination with one of lime, it may be inferred that the lime is simply united with the saponine, and that it does not displace any hydrogen or compound radical; therefore, we should be justified in calculating the formula for saponine in deducting the lime found, and recalculating the percentage proportion. In fact, it may be assumed that saponine has a similar structure to that of arabine, which is said to be a calcium salt.

Another paper read by the same author was

TINCTURE OF QUILLAIA AS AN EMULSIFYING AGENT.

By HENRY COLLIER, Teacher of Pharmacy at Guy's Hospital.

I now pass on to a consideration of the use of a tincture of the bark of *Quillaia saponaria* for the preparation of emulsions. The tincture which has been employed in the preparation of the various mixtures upon the table has been made according to the following formula, which is taken from Guy's Hospital Pharmacopœia:

Quillaia bark, in coarse powder	4 oz.
Rectified spirit of wine	1 pint.

Digest for three days, and then strain.

The bark, before powdering, is carefully freed from all remains of outside layer, and the tincture produced is of a pale yellow color.

Into this bottle I have put some mercury and shaken it up with tincture of quillaia; the result is that the mercury has been reduced to a very fine state of division. It has very much the appearance of hyd. c. creta, and examined with a lens, it is seen to be composed of distinct globules of mercury. So long as there is some tincture present, this division of the metal remains; if it be dried, it at once runs together, and appears in its ordinary liquid state. This is a remarkable power which tinct. quillaiæ possesses of destroying the cohesion between the globules of mercury, breaking them up and preventing them from uniting together, and it is this property which renders it so valuable an emulsifying agent.

A true emulsion consists, as is well known, of a number of oily or resinous particles floating about in a watery liquid by means of some agent which prevents them from cohering. To be perfect, the emulsion should have a milky appearance, and the suspended particles should not subside or rise too rapidly.

In the British Pharmacopœia there is a preparation containing mercury in a very fine state of division, and which is, in fact, an emulsion containing mercury finely divided. The preparation I mean is the *Linimentum Hydrargyri*, which Squire says "should be a lead colored cream, but is curds and whey." By using tinct. quillaiæ a lead-colored cream may be formed which does not turn to curds and whey. The preparation here contains the same proportion of active ingredients as is ordered in the Pharmacopœia. If left undisturbed for some time, the ung. hydrargyri settles to the bottom, but a vigorous shaking blends it again perfectly. The following is the formula:

Lin. camph	ʒj.
Tinct. quillaiæ	ʒiij.
(Liq. amm. fort. ʒij., ♏ 40 aq. ad)	ʒv.
Ung. hydrarg	1 oz.

M.

Chloroform is made into an excellent emulsion by means of this tincture:

Chloroform	♏x.
Tinct. quillaiæ	ʒj.
Aq. destil	ad ʒj.

Misce.

Although chloroform is such a heavy liquid, yet it remains suspended for some minutes after shaking. It finally settles as a creamy layer at the bottom of the bottle. A solution of saponine in water shaken with chloroform converts it into a thick creamy fluid; the water separates, but the chloroform permanently retains its creamy character.

Here is a mixture of castor oil made according to the following formula:

Ol. ricini	ʒss.
Tinct. quillaiæ	ʒss.
Aq.	ad ʒj.

The tincture is first put into the bottle, afterward the oil, and shaken together, then the water is added, and again shaken. The emulsion thus formed resembles its prototype milk in appearance, and like it separates after the lapse of some time into a cream at the top, which mixes again upon agitation. Emulsions prepared in a similar manner, of oleum morrhuæ and oleum olivæ, are of as perfect a character.

Ext. filicis liquid	ʒj.
Tinct. quillaiæ	ʒss.
Aq. destil	ad ʒj.

Misce.

This forms an excellent emulsion, and with the addition of sirup zingiberis ʒ ss. constitutes the Mistura Filicis Maris of Guy's Hospital.

Copaibæ	ʒss.
Tinct. quillaiæ	ʒss.
Aq. destil	ad ʒj.

Misce.

The copaiba in this mixture is perfectly emulsified. Here is an example of an essential oil:

Ol. terebinth	♏xx.
Tinct. quillaiæ	♏xx.
Aq. destil	ad ʒj.

Misce.

This formula, with the addition of tinct. limonis, is the mistura terebinthinæ (Guy's).

I have found that resinous tinctures require more than their bulk of tinct. quillaiæ to prevent any separation of resin.

Tinct. tolut	♏40.
Tinct. quillaiæ	ʒj.
Aq. destil	ad ʒj.

Misce.

The resin deposits after some time, but upon shaking it is easily diffused.

This mixture contains the soluble matter of twelve grains of guaiacum resin in every fluid ounce, so that it is about the same strength as mist. guaiaci, B. P. The following is the formula:

Resin guaiaci	gr. xij.
Tinct. quillaiæ	ʒj.
Aq. destil	ad ʒj.

Dissolve the guaiacum in the tincture, filter, and then mix with the water.

Resin of copaiba is largely used at Guy's Hospital, where it is considered a valuable diuretic. It does not appear to me to make so perfect a mixture with tinct. quillaiæ as the hospital formula with pulv. tragacanth co. The liquid is not thick enough to prevent the resin separating too rapidly. Here are mixtures of copaiba resin made after the following formulas:

Mist. Resinæ Copaibæ (Guy's).

Resin of copaiba	15 grains.
Rectified spt. of wine	20 minims.
Compound powder of tragacanth	15 grains.
Sirup of ginger	1 fl. dr.
Distilled water to	1 fl. oz.

Misce.

The resin and spirit are put into an evaporating dish and blended together by heating over a water-bath, then poured into a mortar containing the pulv. tragacanth co., previously made into a thick mucilage with a little of the water, and well rubbed together, the sirup and the remainder of the water being gradually added.

Resinæ copaibæ	gr. xv.
Tinct. quillaiæ	ʒj.
Aq. destillat	ad ʒj.

The resin is dissolved in the tincture, and the water gradually added with agitation.

Bals. Peru	♏xv.
Tinct. quillaiæ	ʒj.
Aq. destil	ad ʒj.

This mixture is open to the same objection, the balsam subsides too rapidly. The above quantity of balsam with gr. xv. of pulv. tragacanth co. gives an excellent result.

I have now placed before you examples of emulsions of the various substances which are administered in that form, and I have no doubt but that you will agree with me that tincture of quillaiæ is worthy of a place in pharmacy for the preparation of this class of medicines.

Mr. Benger asked Mr. Collier if the taste of the tincture of quillaia was not sometimes objectionable?

Mr. Reynolds said he should like to extend the question put by Mr. Benger. The use of quillaia bark for these necessary purposes of pharmacy would divide itself into two sections, its use for external and its use for internal purposes. The question of physiological action and questionable taste might be taken as parts of the same subject. He would like to inquire if there were any other instances than the use of the male fern oil emulsion, for which Guy's Hospital would recommend the use of quillaia in an internal application, and if they were to understand that the half drachm dose containing six grains of bark was the maximum? Dr. Soulié had recommended an emulsion so as to bring carbolic acid into the form of a lotion, and had written very highly of its effects in the treatment of wounds after certain operations.

Mr. Greenish observed that tincture of quillaia had been highly recommended by the Paris Pharmaceutical Society as an emulsifying agent. He had tried it in many instances, and had found it exceedingly useful. Dr. Vogl, of Vienna, had written most exhaustively on this bark, not only on its chemical composition, but its microscopical structure. There was also a valuable paper on its microscopical structure by Schlesinger in Wiesner's "Untersuchungen." He believed that tinct. quillaia would occupy a place in pharmacy.

Mr. A. H. Mason (Liverpool) remarked that the author spoke of quillaia bark in the natural state. His experience was that only the inner bark was offered for sale in this country. This was frequently stained, and he would like to ask if this was caused by exposure, or if any decomposition took place likely to deteriorate the bark? He would like to know, moreover, if the frothing power of quillaia bark was due to the presence of saponine, and if so, whether saponine obtained from other sources had the same properties? He would also ask whether the watery or the alcoholic extract yielded the greater percentage of frothing power, and what the yield of extracts was?

Mr. Lee asked what strength of spirit was required to extract saponine from quillaia bark, and what temperature should be used?

Mr. Umney said he knew this bark was occasionally used medicinally, also that it was a most powerful drug applied externally. It entered into the composition of one well-known patent medicine which had been before the public for years, and it was well known as a stimulant in certain skin diseases. Before it was recommended broadcast as an emulsifying body for all kinds of mixtures, they ought really to ascertain if it was harmless in its nature when administered internally.

Dr. Symes referred to the use of quillaia bark in tooth powders and mouth washes as objectionable, on account of its nauseous acrid taste, and asked if saponine in the purest form in which Mr. Collier had been able to obtain it still possessed this objectionable character?

Mr. Fletcher asked if the saponifying property was peculiar to the lime compound?

Mr. Hasselby asked how the author broke up the mercury, and said the process seemed so simple and effective that it might be used with advantage in sheep ointment.

Mr. Collier said, as regarded the physiological action of quillaia bark, he could only refer to Husemann's "Pflanzen-stoffe," in which saponine was mentioned as being poisonous to the lower animals; but the fact of its being adopted by the Paris Society of Pharmacy induced him to think there could not be any harm in the substance. He had made a considerable quantity of emulsions with it, but more particularly of cod liver oil. The tincture of quillaia, added to cod liver oil, and flavored with cinnamon, made really a very palatable mixture, and he knew one person who, having an objection to oil, even liked it in this way. He explained the process of breaking up mercury, and showed that it would do well to make sheep ointment.

The thanks of the conference were given to Mr. Collier for his paper.

ANHYDROUS AIR AS A THERAPEUTIC AGENT.*

By G. A. KEYWORTH, F.C.S.

SOME time since my attention was drawn to the great pain and inconvenience caused by tension in various morbid conditions. It occurred to me that air artificially dried and heated, and so made an energetic absorbent of moisture, would give relief by causing shrinking of the parts. This I found to be the case. Frequent opportunities were presented of observing this effect upon a cancerous growth affecting the hand, with moist fetid surface. The jet was applied for an hour in the evening, and caused cessation of pain for some eight hours, insuring a good night's rest. After the application the surface presented a dried, shriveled appearance. The loss of pain and stiffness was well marked and repeatedly verified. Anhydrous air as a mechanical anodyne may therefore prove a useful addition to the therapeutic armory. The medical practitioner may see fit to apply it to gouty and œdematous swellings, to inflamed surfaces, to indolent ulcers and intractable wounds, with a view to promote healing by desiccation, and to various tumors and cancerous growths to relieve the pain and if possible check their increase.

The apparatus I employed consisted of an eprouvette of glass, containing fragments of calcic chloride, through which large volumes of air were driven by means of a foot bellows of the Fletcher type. The exit end of the eprouvette was connected by India rubber tubing with an iron tube 3 feet in length, with a diameter of ½ an inch, having a spirit lamp burning beneath the center, and a piece of India rubber tubing attached to the extremity for the purpose of applying the current. In this manner a stream of dried air heated to 100° F. could be maintained. A plug of cotton wool inserted within the entrance tube to the eprouvette acts as a filter when the jet is applied to unsound skin. The air might (if desirable) be impregnated with carbolic acid or other volatile substance by introducing a portion with the wool. Large volumes of air must be used and for a considerable time (sometimes several hours) in order to produce sensible effects. If the process should be found useful in medical practice, dispensing chemists will probably be called upon to supply the apparatus on hire. An economical form of it will be supplied by the usual dealers in pharmaceutical apparatus. If used in hospitals on a large scale, a small gas engine or hydraulic motor could be adjusted in order to drive large bellows or a fan wheel, the eprouvette being of increased dimensions and the spirit lamp replaced by a Bunsen flame. The addition of India rubber gas bags and pressure boards, or other methods of compression, can be made if increased force to the jet is required.

It may be remembered that warm dry air has long been observed to promote, and cold air to retard the healing of wounds. Anhydrous air, though not a caustic in the usual sense, shares with such substances a certain power of disintegration by its affinity for moisture. The Michel process, introduced in Paris for removing tumors, consisted in the application of a paste of asbestos and sulphuric acid, the latter effecting destruction by absorbing moisture. Caustic potash, soda, and lime act in the same manner.

The effect of nitric acid is due partly to this and to its power of oxidation. Anhydrous air is, however, free from the dangers and objections which attach to the use of these energetic chemical agents.—*Pharmaceutical Journal.*

* Read lately before the British Pharmaceutical Conference.

CEMENTS FOR THE TEETH.

AT a recent meeting of the New York Odontological Society, the following paper, entitled "A Contribution to the Knowledge of Cements," by Dr. William Herbert Rollins, Boston, Mass., was read.

Since 1872 I have tried to find a cement for filling teeth. To avoid loss in rediscovery I have analyzed the cements in the market, finding them oxychlorides of zinc. It has been amusing to see each new cement praised while old ones like it were given up. I have analyzed two cements which have recently been placed in the market. Their resemblance may possibly show another case of independent discovery in different countries.

ANALYSIS.

Fletcher's.		*Weston's.*	
Fluid.	Solid.	Fluid.	Solid.
Phosphoric acid. Phosphate of alumina.	Basic oxide of zinc.	Phosphoric acid.	Basic oxide of zinc, 80 per cent. Silicate of Alumina, 20 per cent.

The silicate of alumina in Weston's cement is inert. The two cements are less irritant than the oxychloride of zinc. They adhere firmly to the tooth. They will not last. Orists will find them cheap and easy to make, a pound not costing much more than is now paid for an ounce. If you buy phosphoric acid, test it. Twenty per cent. of sodium phosphate is often found in the glacial.

Directions for making a phosphate cement: Concentrate pure phosphoric acid till semi-solid; mix aluminum phosphate with it by heating. For use, mix with basic oxide of zinc to the consistency of putty. The light oxide of zinc should not be used here, nor in making oxychlorides. The cement sets in two minutes.

Phosphate cements are not new. See patent No. 159,568, February 9, 1875. As the Patent Office rules that the first inventor may claim a principle broadly, I do not think these cements of Fletcher and Weston can be patented in America.

This patent could probably be bought, for the inventor seems not to have brought his cement into the market.

In covering thin dentine over a pulp we have needed a non-irritant, strong cement, which, though mixed thin, would harden quickly.

By calcining magnesium nitrate an oxide is made. This, when hydrated, forms a durable cement. When mixed with phosphoric acid it hardens at once, growing so hot as to burn the hand. As basic oxide of zinc forms with phosphoric acid a slower-setting cement, the indication is plain. I have used for pulp-capping and temporary filling the following mixture:

Basic oxide of zinc	2 parts.
Oxide of magnesium	5 "

Grind them together. For use, mix to a paste with sirupy phosphoric acid. This sets in thirty seconds. I still believe the future filling will be a cement; these are but transitory.

CURIOUS FOODS.

THE food of man naturally falls into two classes, natural and artificial; the one the product of nature uninfluenced to any great extent by the design of man, the other created or adapted through man's necessities or wisdom. In the former category are included a vast number of substances embracing material of mineral character; the coarsest products of organization, roots, stems, leaves, flowers, spores, and fruit of the most diverse characteristics—bitter, sweet, repugnant, or pleasing, if only capable of affording nutriment or stimulation; animal substance of diverse origin, including the extremes of the natural orders. The illustrations for these statements are found in earth, used as food by various tribes, and even locally within civilized regions; gypsum, of which, according to Medhurst, the Chinese use great quantities, mixed with pulse, to form a jelly, of which they are very fond; rotten wood, as instanced for the Indians of British Guiana; bark of roots, as the quantong (the bark of the root of *santalum persicarium*) of the Murray tribe of Australian savages; bark of trees, as by the Jakuts of Northern Siberia, the inhabitants of New Caledonia, as reported by Cook, and by the Laplanders and Finns; spice barks, as cinnamon, etc; sawdust of resinous woods, like the beech and birch, eaten in Norway and Sweden, boiled and then baked, mixed with flour to form a bread; roots and underground tubers, as the cassava root either sweet or bitter, the latter with a highly poisonous root, and which furnishes an abundant food to the inhabitants of tropical America, and portions of Africa, as in Liberia; the yam, the asphodel, whose root was to the ancient Greeks and Romans what the potato now is to us (Phillips), and others too numerous for reference; stems, as instanced by sago, the product of the palm, and various forms of turio; buds, as the cabbage of the palm, used in tropical regions, and the buds of hard-wood trees eaten in cases of necessity by the Indians of Maine; leaves, as pot herbs, as salads, and of numerous varieties; flowers, as those of the magnolia grandiflora, and of the banana for pickling, of *nuphar lutea* by the Turks in the preparation of cooling drinks, of *abutilon esculentum*, as an esculent in Brazil, of the Judas tree as a salad, of the mowha as a feast-and-plenty ration, of the yellow locust caltha, marigold, myrtle, rose, etc.; pollen, as that of the *typha angustifolia*, which is formed into a bread by the people of Scinde, New Zealand, and elsewhere; seeds and fruit, of which perhaps the most striking instance is that of the colocynth (the bitter apple, bitter cucumber, bitter gourd) found abundantly in the Sahara, in Arabia, on the Coromandel coast, on the islands of the Ægean, and elsewhere, whose pulp is extremely bitter and drastic, but whose seed kernels are used by some of the natives of the desert for food; excrescences, as the gall-nuts or apples of the sage, used for a preserve in Zante.

But this will suffice for illustration. Food plants are also found among the algæ, mosses, fungi, or moulds, but not as abundantly as among the flowering plants. Among animal substances may be enumerated earthworms, regarded as a luxury by the Chinese, if we may believe the evidence of bills of fare; the saliva of birds, as the famed birds' nests; sea slugs; entrails; maws; stomachs of reindeer filled with partially digested willow twigs; raw flesh; putrid flesh; rats and mice, relished, we may remark, by the luxurious Romans of old; carnivora, as the flesh of the jaguar, in South America, and which resembles veal, of the lion, etc.; birds of prey; insects of various species, as flies in Mexico, grubs in Surinam and Jamaica, locusts in the East, lice in southern Africa, the cicada, by the polished Greeks of antiquity, etc.; fæces, even as represented by woodcock trails in England, Schneppendeck of the German epicures; and indeed the list could be extended to include nearly every species of animal which can be recognized by the savage eye. The Abyssinians are said to cut steaks from the living ox, and certain citizens of Bengal seize the live sheep, and devour on the spot, wool, skin, entrails, and flesh, as Captain Smollet witnessed, and which is recorded elsewhere.

Indeed the food of man is just what he can get, and not always what civilized man would desire; and hence but slight research avails to show to us foods we consider curious, unpalatable, or even disgusting. Yet there is more reason for eating the caterpillar which has been nurtured on the clean palm-bud than for eating the lobster which fattens on carrion. The world has not as yet come to exercise pure reason, and lobster will with us always oversell the caterpillar.

Some few years since, while journeying on the Oclawaha River, in Florida, we had pointed out to us numbers of sallow-complexioned people, who were said to be "clay eaters," or people who consumed clay largely, either as a luxury or necessity. This practice seems to be quite an extended one, as instances of like habits are noted throughout the world. Ehrenberg writes of the use of infusorial earth in Europe during times of war, and gives instances in Pomerania, in Dessau, and elsewhere, during the thirty years' war, and subsequently in 1719 and 1733. In this case we may imagine some nutriment of organic matter contained in the fossils; but this is not necessary, as we find other instances of clay, gypsum, etc., being used when the material is entirely inorganic.

The name of Panama is derived from panamante, a substance which the Indians of Central America prepared from a mealy gypsum-powder found in the Sierra. The earth which the Otomacs in northern Brazil eat is an unctuous, almost tasteless clay of a yellowish-gray color. This clay is collected by the natives with great care, as they discriminate between the flavor of different kinds. The clay is kneaded into balls of from four to six inches in diameter, and is then baked before a slow fire until they attain a reddish color. When eaten these balls are moistened. An Indian will eat from three-quarters to a pound and a quarter of this clay a day, and consume it as a food in the rainy season, when other food is difficult to be procured, and as a luxury at other times. The eating of this clay, as Humboldt observes, seems not to affect their health; and he makes the pertinent inquiry, 'Has this tribe been habituated for generations to this stimulus?"

The Indian women who are engaged on the river Magdalena, in turning earthenware pots, continually fill their mouths with large lumps of clay.

In many parts of Peru, calcareous earth is sold in the streets as an article of food for the Indians.

The natives of New Caledonia, to appease their hunger, eat lumps as large as the fist, of a friable steatite.

In Java, Labillardiere saw small reddish cakes of clay sold publicly in the villages for eating.

In Guinea, the negroes eat a yellowish earth, which they call caouac, and when carried to the West Indies as slaves they endeavor to procure a similar earth as food. In Guinea it is said not to cause inconvenience, but the eating of the earth was forbidden in the West Indies on account of the injury to health, and slaves found transgressing were barbarously punished. Notwithstanding the penalty, a species of red or yellowish stuff was secretly sold in the public market of Martinique, in the year 1751.

Berzelius and Retzius state that in the more remote parts of Sweden, hundreds of cart loads of earth containing infusoria, are annually consumed by the country people as bread meal, more from fancy than necessity. In some parts of Finland, a similar kind of earth is mixed with bread.

This earth-eating habit seems more prevalent in the warmer regions of the earth; and Humboldt observes that in the tropics it is often found necessary to shut children up, in order to prevent their running into the open air to devour earth after recent rain. The practice is generally recognized as injurious to the health or appearance of those who habituate themselves to it, although the Otomacs above mentioned seem to offer an exception.—*Scientific Farmer.*

FERMENTATION AND PUTREFACTION OF MILK.

By T. J. BURRILL, Professor of Botany and Horticulture, Illinois State University.

IN early times, with peoples as with individuals, the changes which occurred in such a substance as milk when allowed to stand for some time excited no curiosity, stirred no one to inquire why the phenomena presented took place. If any thought was given to the subject, a satisfactory conclusion was reached when it dawned upon the mind that milk soured because it was its nature to do so; it became unpleasantly odoriferous because it could not continue otherwise. From this low beginning it is a long way, and by no means one without difficulties, to the full knowledge now possessed of the changes and their causes which take place so persistently in so common an article as cows' milk. It is possible that some whose business makes them more especially interested do not yet appreciate the fact that all these ordinary changes arise from the action of *living organisms* altogether foreign to the constituents of the milk itself.

For a long time the idea has been current that, in such organic compounds, changes arise through spontaneous chemical agencies; that the oxygen of the air is the chief factor in the production of the results observed. This was supposed to be confirmed by the fact that driving the air out by heat causes the changes to come later, or upon excluding the air altogether, as by heating and canning, they occur not at all. But it has been demonstrated that pure air may have free and abundant access to putrescible compounds such as milk, without the latter becoming in the least affected. There is no souring, no fermentation, or decomposition of any kind. The milk retains its freshness and purity for an indefinite length of time; only the steady desiccation causes the least change. The conditions are that the air be entirely freed from suspended particles, and that the vessels be absolutely cleaned, or heated to a sufficient degree to kill all living atoms and their germs. It has been shown that

air sufficiently filtered through clean cotton-wool, or even allowed to settle in a perfectly quiet reservoir, is inert—absolutely incapable of producing fermentation or decay. Under such circumstances temperature has no effect. The protected liquid is preserved just as well at 90° Fahrenheit as at the freezing point. A liquid keeps its fresh condition as well as a solid body from which all water has been evaporated.

One point remains to be fully determined. Does milk, in common with other fluids secreted within the body of an animal, contain, before it reaches the external air, the germs which by development and multiplication may cause the changes usually observed? In cases of disease, living germs are often found in all the animal fluids, and peculiar phenomena have been witnessed in such fluids after extraction and exposure.* On the other hand, one looks in vain, with the aid of the best microscopic instruments, for such living particles in the same fluids from animals in perfect health; at least this has been the case in the personal observations of the writer. Blood has been drawn with instruments made for the purpose, and kept absolutely free from living organisms, though not excluded from other agencies to which fermentation is assigned, and preserved indefinitely without heating above the normal temperature of the animal from which it came. There can scarcely be a question but that in the case of perfectly healthy cows, fed upon proper diet and drinking pure water, the milk would for ever keep sweet and good, if preserved from contact and inoculation with living germs after it leaves the udder. This latter, it is true, is a difficult accomplishment, but, as an experiment, it can be done; and we certainly would be unwise to assert that it will never be done in a simple and practical manner adapted to ordinary use. Some simple device may overcome the almost insurmountable obstacle now met with, and introduce a new era in the dairy business and household economy, leaving us all to wonder why it was not thought of sooner. Indeed, much progress has already been made in this direction, attained for the most part by common observation and practice. Thoroughly scalding the vessels—and this just before as well as just after use—keeping everything clean, and especially free from decomposing substances, beginning with the stable and ending with the arrangements for final disposition of the products, the lowering of the temperature, and finally the introduction of some tasteless and harmless antiseptic materials as dilute solutions of thymol, boracic and salicylic acids—all looking toward the prevention of infection by and development of microscopic germs—surely this is progress. When thoroughly understood and appreciated that these and similar operations are really for the purpose of killing or retarding the development of living organisms, capable of wondrously multiplying themselves in a very short period of time and causing the uninvited phenomena which so constantly present themselves in the absence of these precautions, and when it is further confidently known that the destroying agents are altogether foreign to the prized liquid itself, shall we not use the means already at our hand with more intelligence, in better directions, by more economical methods, and with surer results? It is so now. Those who have adopted the germ theory of fermentation in all its phases, and proceed accordingly, are most and surest successful in the management of milk.

We have been so long accustomed to the idea that organic bodies, and especially those of animal origin not wholly freed from water, *spontaneously* decompose, it is exceedingly difficult, without ocular demonstration, to fully comprehend that in and of themselves such substances as milk, urine, blood, etc., are as stable and unyielding to the inorganic elements as the stone of which the everlasting hills are composed; yet this is the doctrine which is now and here advocated. It is the doctrine upon which is based the great domestic and commercial interests in the canning of fruits, meats, etc., and even in the desiccation of these products. But, it may be asked, are there *no* changes in the character of milk, in the flavor of cheese, as in "ripening," or the quality of butter, as when becoming old and rancid, not brought about by the action, direct or indirect, of living things too small to be recognized by the unaided eye? What, for instance, is the reason that the liquid in which a bit of a calf's stomach (rennet) has been macerated in a warm place so soon causes sweet milk to coagulate? Is this, too, dependent upon particles possessed with an individuality of life quite independent of that of the animal from which the stomach came? Is, indeed, the calf itself indebted to such assistance from myriads of microscopic but effective agents? Is the digestion of our own dinners this day brought about, not wholly by ourselves, but by multitudes of co-laborers that have never received our thanks for their important services?

The asking of such questions may be considered fanatical, even distasteful or almost sacrilegious by some; yet he who thinks closely and observes carefully, especially if he has the time and means for proper investigation, cannot avoid them if he enters upon the subject at all. The microscope shows in the solution from rennet as much of the germ theory of change as it does in the fermentation of milk when left exposed in the ordinary manner; and this evidence is convincing in a very high degree. Other phenomena coincide to make the conclusion irresistible. The living organism in the rennet is killed by heat; it propagates itself in a suitable liquid with the astonishing rapidity of its congeners usually found outside of living animals; a little used as seed permeates a great bulk of nutritive substance, as a little leaven (yeast, a plant), in the olden as well as the modern time, leavened the whole lump. The rennet plant can thus be cultivated, as the yeast plant is, and possibly in a much more convenient method than at present known. It *is* a plant, living, multiplying, absorbing, assimilating, dying—very low in the scale of classification, and scarcely differing from the equally low forms of animal life, yet having a definiteness and individuality which in some respects those of the highest rank, the lords of creation, might do well to imitate.

Let this example suffice. If the coagulation of sweet milk, by the aid of rennet, can be proved to be due to the action of organisms in a living state, are we not prepared to accept the same or a similar agency for any change which we observe in this, apparently, unstable fluid? But the evidence concerning some of these changes, as that of souring, is still more direct, certainly better and more generally known. We cannot be far wrong in concluding that all the processes through which milk and its products pass are results, direct or indirect, of living, lowly organized plants or animals.

What is the nature of the microscopic creatures to which such marked results are attributed? The word *fungi*, now in general use, is commonly introduced whenever any name is applied to the organisms with which we have to deal. But this is applied to an immense order of plants of which the members differ among themselves almost as much as the trees of the forests and grasses of the fields. They have something in common as to their food and mode of life, but differ wondrously in appearance, in size, in method of propagation, etc. There are probably not less than twenty-five hundred species of fungi growing naturally in Illinois. Some are found upon old logs, some on upright trunks, some on or in the soil, some only on the excrements of animals, some on dead twigs, some on living leaves, some on the skins of living animals, and some in decomposing fluid substance. We can hardly imagine a place on or in the earth, or organic substance of any kind where, or upon which, fungi are not found, of one kind or another. We pride ourselves upon our cleanliness; but it is not hazardous to assert that every human being in our broad prairie State has living fungi in his mouth. Nevertheless the ubiquitous beings are subject to prescribed conditions of growth. They must have the proper food, each according to its kind, the proper amount of moisture, the proper degree of heat, etc. The well-informed advocate of spontaneous generation of organic species does not think of asserting that the specific forms now existing are self-produced from the inorganic elements. Whether this process is ever true or not, even the lowest forms that can be classified and so distinguished as fungi have, as all scientists admit, sprang from parents like themselves. If spontaneous generation is true, it applies to still lower living atoms, which reach characteristic distinctiveness only through long series of development, and so gradually change as scarcely or not at all to be noticed within the span of a human life. We may therefore say the species of fungi are as distinct as those of the higher plants with which we are better acquainted.

Again, the names mould or mildew are very often used in connection with such fungi as are supposed to be the cause of disease, of fermentation, putrefaction, etc. But these are so general in their application that little or no information can be conveyed by their use. If restricted to such species as are so commonly met with on bread, cheese, fruits, etc., the popular statements in regard to their effects are much exaggerated. For a long time it was supposed that yeast used in the making of bread and beer was a submerged form of various species of true moulds; but this is conclusively shown to be an error. The blue mould that forms on bread is not the same or nearly the same as that which causes the fermentation of the flour in the process of rising. The moulds of different kinds which appear around the edges of a neglected milk pan bear no relation to the much simpler form which induces the souring. It is probable that the species of moulds in a restricted sense do cause some of the phenomena to which this paper is devoted; but they are far from being the principal agents in the work. When they occur on milk that has stood in a warm place for some time, it may be observed that there is a conspicuous absence of the putrid odor arising from such milk devoid of the moulds. These are, in fact, scavengers converting the partially decomposed materials into odorless carbonic acid and water.

Professor Law, some years ago, published in the *Lens* drawings of fungi which he believed were developed in the milk from germs taken by the cows in the water they drank. After careful inspection of the figures, it seems almost certain to me that an error was made in the interpretation of these growths. His general conclusion may have been correct—probably was; but the organisms he observed were not those causing the difficulty. It is exceedingly doubtful whether the germs of any fungus of the rank and development of the common moulds ever passed through the secretory apparatus of any animal. The crude statements about *Tilletia caries* (bunt of wheat), etc., being found in the blood of cattle has been often enough refuted.

In a recent classification of fungi (Sachs' Text book of Botany), two orders are given, including plants of lower grade than any known moulds, which embrace the principal agents in these processes of fermentation and putrefaction of milk and other substances; *viz.*, the *Schizomycetes* and the *Saccharomyces*. The former includes the organisms known as *bacteria* and *vibrios*, all microscopic, and some of them the smallest living things of which we have any knowledge; the latter contains the yeast plants. Speaking of those of the first order in a wide sense as bacteria, it may be said that they are so minute that they were entirely unknown until the microscope reached a high degree of perfection; and for this same reason their presence is still often overlooked. But it is to these almost invisible objects that we must attribute the main effects in the processes of which we write. It is to these that contagious diseases are mostly due, if indeed to any living thing. I have been permitted, through the courtesy of Dr. H. J. Detmers, one of the United States commissioners for the investigation of the so-called hog-cholera, to repeatedly observe in the blood, contents of the intestines, urine, etc., of disensed pigs great numbers of infinitesimal objects belonging to this group. Upon inoculation, or in some cases upon feeding these living atoms to healthy swine, the disease was produced time and again. Introducing a half drop of blood serum containing these bacteria into a vial of pure milk, the latter soon became swarming full of the same objects. Again transferring a minute portion of the infected milk to fresh material like the first, multiplication of the bacteria took place, and inoculation from the second vial in the ear of a pig produced the disease in about the same length of time as before. To see the form of these organisms a glass of excellent definition was required, and a power of at least eight hundred diameters. Yeast cells (of bread) are mountains compared with them. If any living things find their way through the animal tissues and escape, as with the milk, we may safely conclude it is something of this description. There is no evidence that higher and larger fungi as ordinary moulds are ever developed from the minute forms described.

When fresh milk from healthy cows is placed under a high magnifier (500 to 1,000 diameters), the thin stratum appears violently agitated by currents caused by evaporation, etc., and by the molecular, oscillating motion known as the Brownian movement; but no bacteria can be found. Examine the same milk after it has stood in a warm place a few hours, and before evidence of acidity except to litmus paper is presented, a few bacteria may be observed; before coagulation they are quite common, and finally become in some cases excessively numerous. Milk put in well-stoppered, scalded vials, kept in a temperature of from 80° to 90° Fahr., sometimes becomes very sour, but suffers no further change. But frequently after souring, the inclosed liquid becomes putrid and highly odoriferous. Upon examining two such of these, the difference can be ascertained. The former contains one kind of bacteria, the latter two. The first is at the outset minute and spherical or cylindrical, and composed of joints which are often more or less bent upon each other. Its movements are of an oscillatory character, with slight or no progress in any direction. The second is not unlike the first in shape, though not so distinctly composed of easily separated joints; but it moves with an endwise, sliding motion of apparent—under the microscope—great rapidity. One is the lactic ferment, the other is the putrefactive ferment. They may occur together, or either may exist without the other. But the lactic organism appears either more common or more active in its work.

In one experiment, three small dishes were placed in the same tin vessel, which closed tightly. Milk fresh from a cow was placed in all of the inclosed dishes, which were of glass with open top. In number one, the blade of a penknife was dipped which had previously been inserted in sour milk swarming with the lactic ferment. In number two, a minute amount of milk just coagulated was placed, and number three was left as it was. Coagulation took place in the order named, with about two hours intervening between the first and second, and six hours between the second and third. After two days, a mould whose creeping filaments were previously observed appeared on the first, and after one more day upon the second, but the third became wholly dried before the mould fruited. This mould proved to be *Mucor mucedo*.

Other experiments confirmed the announcements made by observers, that bacteria are disseminated slowly through the air, while mould fungi fly readily everywhere. The former are especially distributed with liquids, and remain, though dried, in contact with solid surfaces, ready to commence action at any time nutritive substances reach them. The minutest quantity of old milk, not thoroughly scalded, may infect any bulk of fresh material.—*Scientific Farmer.*

* Professor Orth, of Gottingen, Germany, says: "Recent researches leave no doubt whatever that in some diseases the blood contains during life, though to a far higher degree after death, certain low forms of animal or vegetable life."

Dr. Wm. Roberts, of Manchester, England, says the germ theory of disease "is now established upon a firm experimental basis."

Dr. Obermeir, of Berlin, and Professor Stricker, of Vienna, find low plants, fungi, in the blood of patients suffering from relapsing fever.

Dr. Nafzel, of New York, says: "My experiments so far lead me to the conclusion that the lower vegetable organisms can continue to live and multiply in the tissues of living animals."

Dr. J. G. Richardson, of the University of Pennsylvania, reports the experiment of swallowing bacteria and afterwards finding numbers of them in the blood drawn from his finger.

A NEW FOOD FOR CATTLE.

"'Tis an ill wind that blows nobody good." For years past there have been loud complaints of the pestilent water-weed known as *Elodea canadensis*, which it has sometimes been said is likely eventually to choke up our water-courses altogether. Now it appears that this same obnoxious weed is a valuable food for live stock. In consequence of its having been repeatedly observed that oxen ate the *Elodea canadensis* with great avidity, Dr. W. Hoffmeister recently undertook an analysis of the plant for the purpose of determining its comparative nutritive value. The results of his investigations are now published in *Fühlings Landwirthschaftliche Zeitung*. One hundred and fifty grammes of the weed yielded 18 grammes of dry substance, equivalent to 88 per cent. water and 12 per cent. of dry matter. By Schulze's method 16·02 grammes of cellulose were obtained; the average proportion of protein was 18·46 per cent. Of the residue of an ethereal extract, 0·15 per cent. was found to be insoluble in sulphate of carbon. The proportion of sugar was 23·02, and of starch 19·40 per cent. In order to estimate the substance soluble in an aqueous solution, a sample was thoroughly exhausted in cold water. The residue, when dry, reached 25·17 per cent. and yielded 2·89 per cent. of nitrogen, equivalent to 18·06 protein, showing that almost the whole of the albumen has passed over in solution. Judged by the proportion of nutritive matter contained in it, the weed appears, therefore, to be about equal in value to the best hay, or to a good quality of clover, and should, consequently, be well worthy of consideration as a food for live stock, where it is met with in anything like considerable quantities.

HAY AS FOOD FOR HOGS.

SAYS the Nebraska *Farmer:* "But few men are aware of the fact that hay is very beneficial to hogs, but it is true nevertheless. Hogs need rough food as well as horses, cattle, or the human race. To prepare it you should have a cutting box (or hay cutter), and the greener the hay the better. Cut the hay as short as oats, or shorter, and mix with bran, shorts, or middlings, and feed as other food. Hogs soon learn to like it, and if soaked in swill, as other slop food, is highly relished by them. In winter use for the hogs the same hay as you feed to your horses, and you will find that while it saves bran, shorts, or other food, it puts on flesh as rapidly as anything that can be given them. The use of hay can be commenced as early as the grass will do to cut, and, when run through the cutting box, can be used to advantage by simply soaking in fresh water until it sours."

STANDARD REQUISITES FOR POULTRY.

THERE are certain things absolutely necessary for the thrift, comfort, and convenience of fowl stock which must be supplied by every one who attempts to raise them. These requisites, in general terms, are a sufficient quantity of lime among their food to assist in egg-shell making; plenty of gravel, which helps to digest their hard, dry grain food; a due allowance of animal substance, such as insects, meat, scraps, etc.; a moderate supply of shells, pounded bones, etc., and a full modicum of green feed constantly the year round. All these are necessities. And in some shape or other these must be furnished the fowls or they will not grow well, feed well, breed well, lay well, or do well. If the flocks are permitted to run at large the birds will gather a good share of these supplies abroad, especially in the summer season. If they are confined within fenced runs, all these provisions must be accorded them artificially, or they suffer.—*American Poultry Yard.*

LARGE FLOCKS PROFITABLE.

A LONG ISLAND farmer writes to the Riverhead *News* that he kept on an average the year round 175 hens in one flock. He sold 1,212 dozen of eggs at an average of 27½ cents per dozen, amounting to $574.77. He raised 340 chickens, of which he sold to the amount of $71.53, reserving 156 pullets for the next season. His fowls all run together. He finds no trouble in wintering 300 in one flock, and they lay well. The fowls always have corn laying before them, summer and winter, and in cold weather they get warm bran and meal puddings in addition. When the ground is covered with snow they get timothy and clover hay, chopped fine and boiled, the hay being fed to the fowls and the water used to wet their bran and meal. He finds this food causes them to lay nearly as well in writer as is usual in summer.